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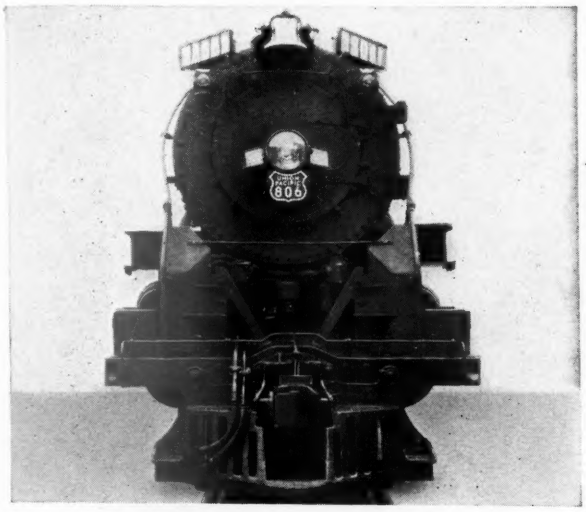

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GRANDFATHER COULDN'T DO IT

RAILWAY
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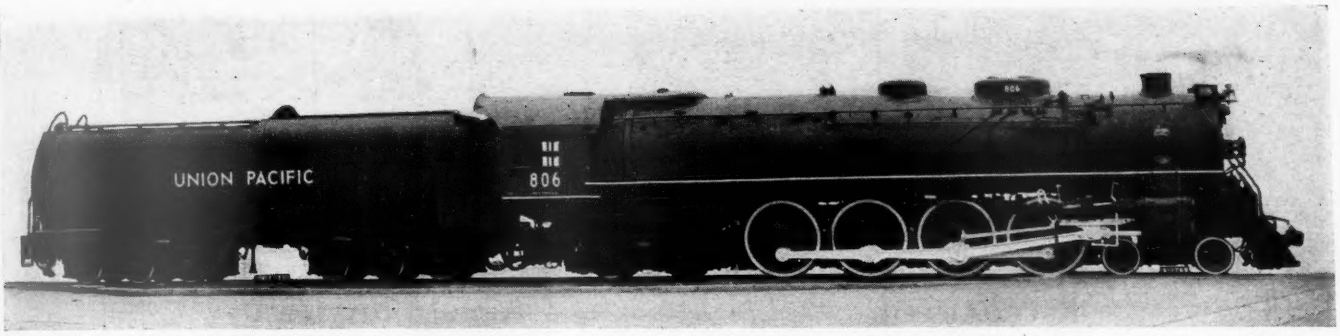


One of the Union Pacific 4-8-4 passenger locomotives

Union Pacific

Heavy Passenger Locomotives

American builds 4-8-4 type which weighs 465,000 lb. and develops 63,600 lb. tractive force—Unusual features include cab supported entirely on the boiler and side rods without the usual knuckle joints at the intermediate-rod connections

THE American Locomotive Company recently delivered to the Union Pacific 20 passenger locomotives of the 4-8-4 type which were designed throughout for speeds up to 90 m.p.h. They are being run at average road speeds of 60 m.p.h. and have given satisfactory performance at speeds in excess of 100 m.p.h., maintained in several instances on down grades. These locomotives develop a starting tractive force of 63,600 lb. They have a total engine weight of 465,000 lb., of which 81,200 lb. is on the engine truck, 270,000 lb. on the drivers and 113,800 lb. on the trailing truck. The tender in working order weighs 366,500 lb. The driving wheels are 77 in. in diameter; the cylinders are 24½ in. by 32 in., and the overall length is 110 ft. 7⅛ in. The boiler, which carries a working pressure of 300 lb. per sq. in., has a combined heating surface of 6,070 sq.ft. and the firebox has a grate area of 100.2 sq.ft.

Frames and Running Gear

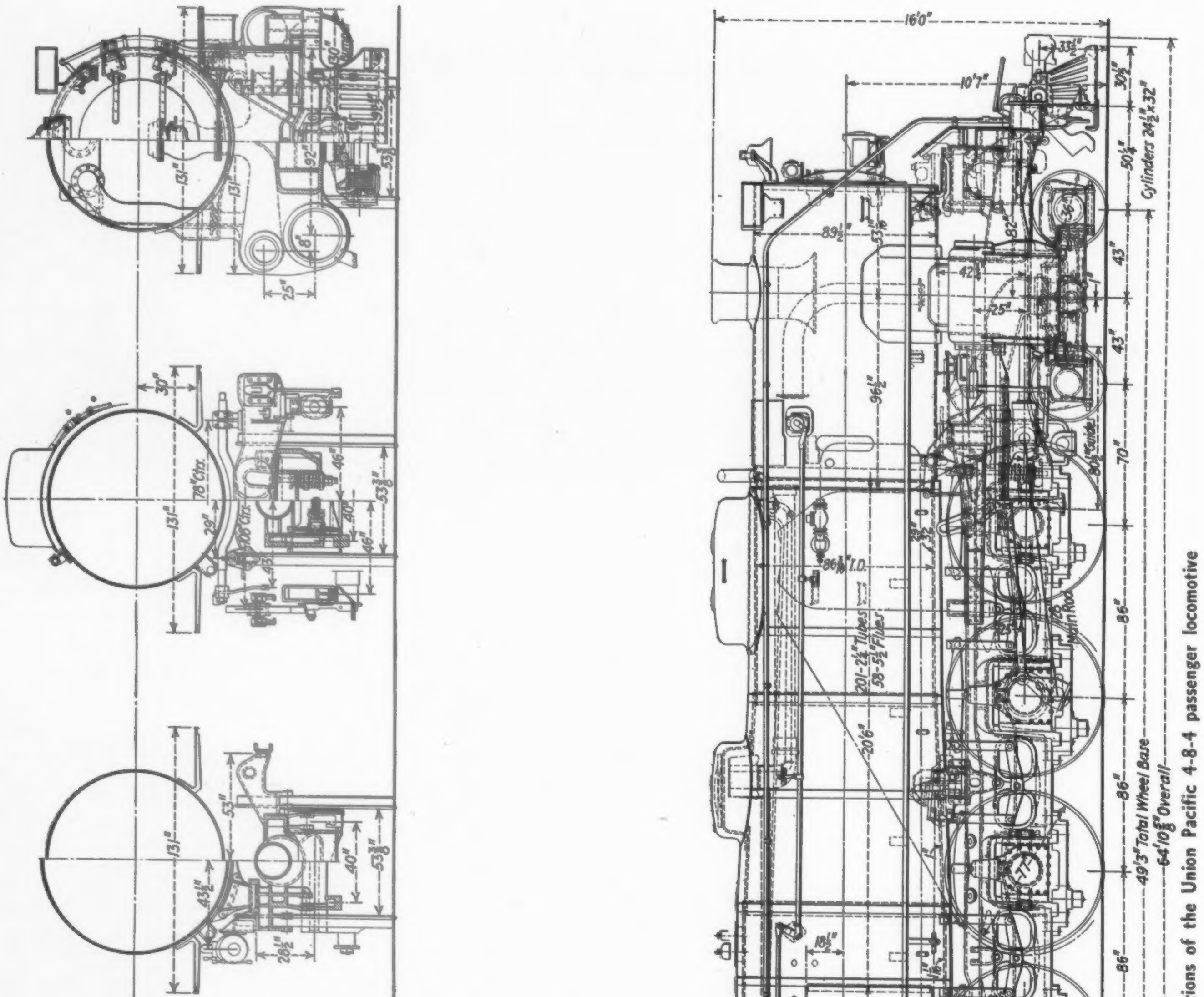
The frames are one-piece steel castings made by the General Steel Castings Corp., which include cylinders, back cylinder heads, main air reservoirs, supports for the air pumps, supports for the guides, and supports for the reverse gear brackets. The front bumper is a steel casting, separate from the body.

One of the outstanding features of these locomotives is the side-rod design, which is a development of the Union Pacific. As shown by the drawings, the side rods have no knuckle joints on the front and back sections. The rear end of the front side rod is 2$\frac{3}{16}$ in. wide and is mounted between the jaws of the front end of the intermediate rod with $\frac{3}{16}$ in. total clearance. A brass bushing is pressed in the rear end of the front side rod and this runs on a steel bushing pressed in the jaws of the intermediate rod which, in turn, runs on the usual floating bushing on the pin. The back side rod is a duplicate of the front side rod, the front end being 2$\frac{3}{16}$ in. wide, and fits between the jaws at the back end of the intermediate rod. The outer ends of the front and back side rods, as well as the back end of the main rod, are channeled to reduce weight to a minimum.

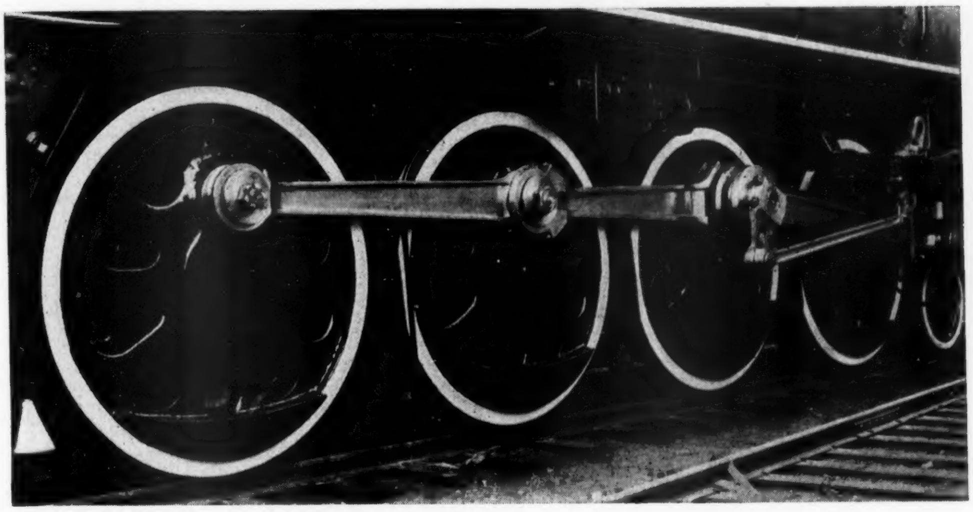
The driving wheels are of the Alco Boxpok type and are cross-counterbalanced on the main drivers only by auxiliary blocks set at right angles to the main counterbalance. The total reciprocating weight on each side is 2,060 lb. The over-balance per wheel on the front drivers is 213 lb.; on the intermediate drivers, 215 lb.; on the main drivers, 163 lb.; and on the back drivers, 207 lb. The dynamic augment at 90 m.p.h. on the front driver is 14,900 lb.; on the intermediate driver, 15,000 lb.; on the main driver, 11,400 lb., and on the back driver, 14,500 lb.

The driving boxes are fitted with Timken roller bearings and one-piece Timken bearing housings. The first and third drivers are equipped with Alco lateral cushioning devices. The driving axles are of low-carbon nickel steel, quenched and tempered, and have ground wheel fits and journals. The main drivers are hollow bored 4 in. and have 13¾-in. journals, while all the other axles are hollow bored 3½ in. and have 12⅝-in. journals. The engine-truck and trailer-truck axles are of medium carbon steel and also have ground journals. The front drivers have ⅝-in. lateral on each side; the main drivers have ¼-in. lateral on each side, and the Nos. 3 and 4 drivers have $\frac{3}{16}$-in. lateral on each side.

The spring suspension on each side is snubbed by two outer coil Class G springs set in tandem beneath a cross



Cross-sections and elevations of the Union Pacific 4-8-4 passenger locomotive



The front end of the back side rods and the back end of the front side rods are tongued to fit between the jaws of the intermediate sections and run directly on the crank pins, thus eliminating knuckle joints

equalizer located ahead of front driving-wheel axle, and by one outer coil Class G spring on the lower end of the hanger at the rear end of the trailing truck.

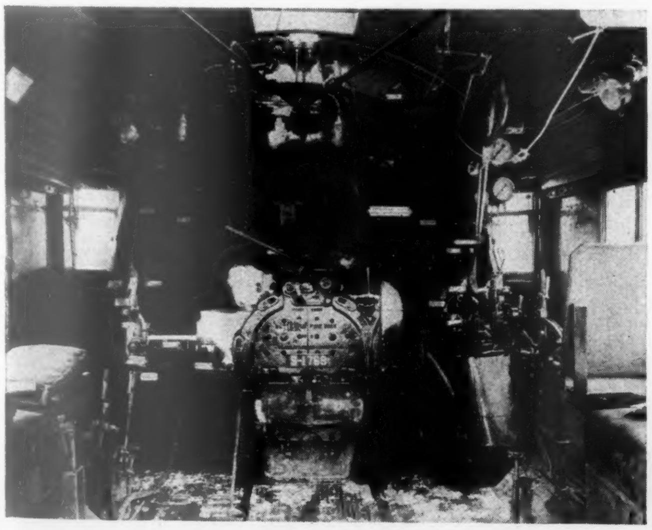
The valve gear is of conventional Walschaert design. The Franklin Ragonnet Type E reversing gear, with a 10-in. cylinder, is used on 15 engines, while the remaining five engines are equipped with Alco Type G reverse gear. The engines are designed to operate at 80.8 per cent cut-off.

The guides and crossheads are of multiple ledge design and are surfaced with pure tin. The main rods, side rods and crank pins are of low-carbon nickel steel, quenched and tempered. The crosshead pin is of medium-carbon steel and is ground. The piston rods are of low-carbon nickel steel and have ground tapered fits.

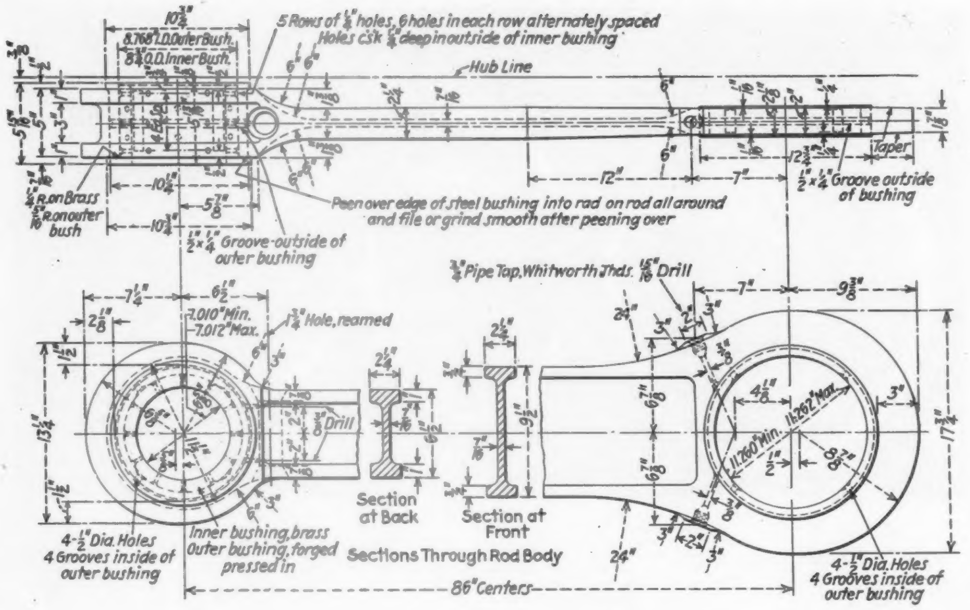
The pistons are of solid rolled steel in Z-section, fitted with the Locomotive Finished Material Company's com-

General Dimensions, Weights and Proportions of the Union Pacific 4-8-4 Type Locomotives

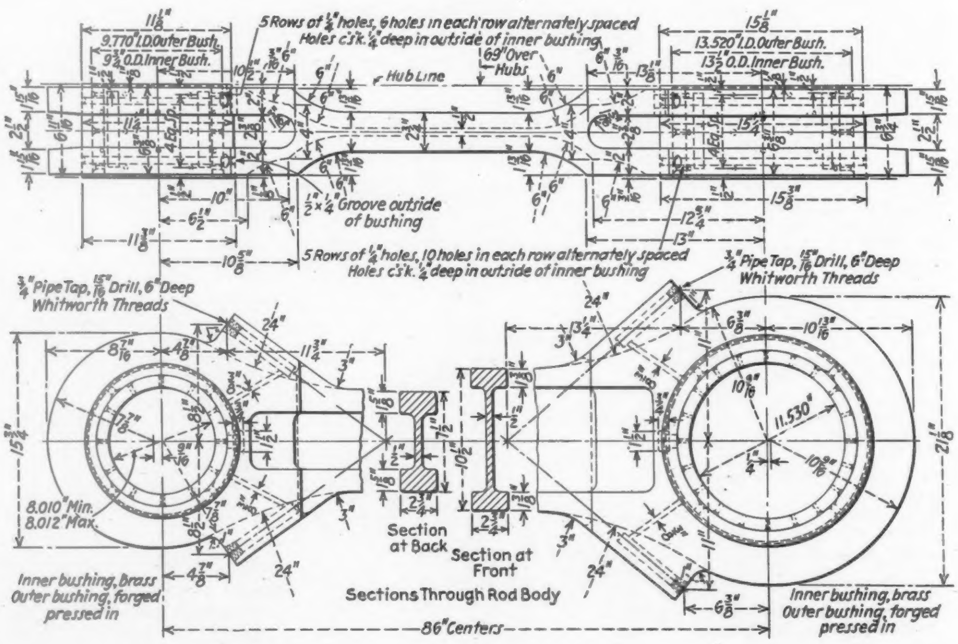
Railroad	Union Pacific
Builder	American Locomotive Co.
Type of locomotive	4-8-4
Road number	800-819
Date built	July-September, 1937
Dimensions:	
Height to top of stack, ft. and in.	16– 0
Height to center of boiler, ft. and in.	10– 7
Width overall, ft. and in.	10–11
Cylinder centers, in.	92
Weights in working order, lb.:	
On drivers	270,000
On front truck	81,200
On trailing truck	113,800
Total engine	465,000
Tender	366,500
Wheel bases, ft. and in.:	
Driving	21– 6
Total engine	49– 3
Engine and tender, total	97– 6
Wheels, diameter outside tires, in.:	
Driving	77
Front truck	36
Trailing truck (rear wheel)	45
Trailing truck (front wheel)	36
Engine:	
Cylinders, diameter and stroke, in.	24½x32
Valve gear	Walschaert type
Maximum travel, in.	7
Steam lap, in.	1⅜
Exhaust lap, in.	0¼
Lead, in.	0 5/16
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	86 9/16
Diameter, largest, outside, in.	102⅜
Firebox length, in.	150 1/16
Firebox width, in.	96 9/16
Height, mud ring to crown sheet, back, in.	76
Height, mud ring to crown sheet, front, in.	90½
Combustion chamber length, in.	72
Tubes, number and diameter, in.	201– 2¼
Flues, number and diameter, in.	58– 5½
Length over tube sheets, ft. and in.	20– 6
Fuel	Soft coal
Stoker	Standard type BK
Grates, type	Firebar
Grate area, sq. ft.	100.2
Heating surfaces, sq. ft.:	
Firebox and combustion chamber	422
Arch tubes	57
Firebox total	479
Flues and tubes	4,118
Evaporative, total	4,597
Superheating	1,473
Combined evap. and superheat.	6,070
Tender:	
Style or type	U-shape
Water capacity, U. S. gal.	20,000
Fuel capacity, tons	25
Trucks	12-wheel
General data:	
Rated tractive force, engine, 85 per cent, lb.	63,600
Weight proportions:	
Weight on drivers ÷ weight of engine, per cent	58.00
Weight on drivers ÷ tractive force	4.25
Weight of engine ÷ combined heating surface.	76.5
Boiler proportions:	
Firebox heating surface, per cent of combined heating surface	7.9
Tube-flue heating surface, per cent of combined heating surface	67.8
Superheating surface, per cent of combined heating surface	24.3
Firebox heat. surface ÷ grate area	4.78
Superheat. surface ÷ grate area	14.7
Tube-flue surface ÷ grate area	41.1
Comb. heat. surface ÷ grate area	60.5
Tractive force ÷ grate area	635.0
Tractive force ÷ combined heating surface	10.5
Tractive force X diam. drivers ÷ combined heating surface	808.5



The cab interior—The cab is supported completely on the boiler



Details of the back section of the side rods



Details of the intermediate section of the side rods

bined bull ring and packing rings. The valve chambers are fitted with Hunt-Spiller bushings and the valves are of Hunt-Spiller lightweight design with duplex packing rings. Paxton-Mitchell packing is used on both valve stems and piston rods.

The locomotives have Alco four-wheel engine trucks with inside SKF roller bearings and cast-steel wheels. The trucks are equipped with lateral resistance of the geared roller type. These are built with a low initial resistance, gradually building up to a higher resistance which becomes constant after about 1 in. of lateral movement. The vertical damping device which is built into each side of the engine truck consists of fiber discs mounted on a horizontal spindle at each side of the truck frame. Between the fiber discs are two rotating metal plates, projecting from each of which is a tongue by which it is connected to the end of the bolster, by linkage. The links are on opposite sides of the spindle about which the plates rotate. Any vertical movement of the bolster with respect to the truck frame, therefore, causes the discs to rotate in opposite directions, a movement which is restrained by the adjustable friction load on the discs imposed by a coil spring on the horizontal spindle.

The trailer truck is of the Commonwealth four-wheel Delta type. The centering device on this truck is designed to produce an initial resistance of 8 per cent which builds up to a constant resistance of 16 per cent. The trailer-truck wheels are fitted with SKF roller-bearing journal boxes of the outside type. The rear trailer wheels which are 45 in. diameter have cast-steel centers, while the front wheels of 36 in. diameter are rolled steel, quenched and tempered.

The engines are equipped with 8½-in. air compressors and a main reservoir with a capacity of 91,000 cu. in. Clasp type brakes are used on the trailer-truck wheels, while the brakes on the drivers consist of a single brakehead design with double shoes. The braking ratios are 60 per cent on the drivers and 45 per cent on the trailer-truck wheels.

National spring washers of the heavy track type are used on guides and binders, smokebox front end, stack and extension, trailer pedestal binders, tender-truck pedestal binders, pipe clamps, running board and cap bolts, and pilot-beam bolts. A large proportion of the bolts

used in the locomotive—such as those used in the trailer-truck pedestal caps, smokebox ring, all finished tapered bolts, boiler studs, cylinder heads, steam-chest studs, eccentric-crank bolts, frame bolts, steam-pipe bolts and studs, exhaust pipe, reverse-gear bracket, exhaust-steam injector, air pumps and force-feed lubricator—are of nickel steel. Chrome-nickel steel is used for injector-check studs, main-rod-wedge bolts, engine-truck pedestal thimble bolts, front crank-pin collar bolts, guide bolts and pedestal cap bolts.

Lubrication

Each locomotive is equipped with one two-feed hydrostatic lubricator for the stoker, one of the feeds being blank. Ten of the engines are equipped with Nathan mechanical lubricators, while the other ten are equipped with Detroit mechanical lubricators. The air pumps are lubricated by a six-feed, force-feed mechanical lubricator furnished by the Westinghouse Air Brake Company. Soft grease lubrication is used for motion work, the bell, spring rigging, brake rigging and engine- and trailer-truck surfaces.

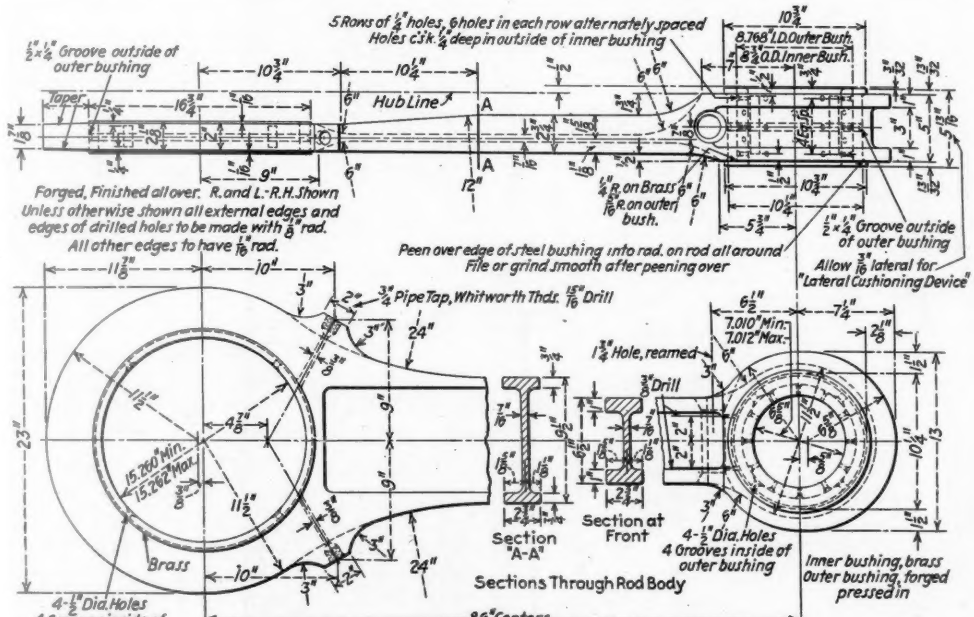
On those engines equipped with Nathan mechanical lubricators, a DV-4 20-pt. model is used on the right side, while a DV-5 26-pt. model is used on the left side. From the lubricator on the right side one feed runs to the top of the cylinder barrel, one feed to the bottom of the cylinder barrel, two feeds to the steam chest and one feed to the throttle pilot valve, all these feeds being fitted with atomizers. From the lubricator on the left side eight feeds run to the driving boxes, with a four-way divider in each line, to feed oil to the two pedestal faces and to both sides of a Franklin snubber wedge. Two feeds run to the trailer truck, each line having a four-way divider, thus furnishing lubrication for the eight pedestal faces. One feed with a four-way divider furnishes lubrication for the guides.

On those engines equipped with Detroit mechanical lubricators a Model A 24-pt. unit is used on the right side and a Model B 32-pt. unit is used on the left side. The lubricator on the right side has four feeds to the cylinders through four-way dividers and high-pressure checks, two feeds to the steam chest, and one feed to the throttle pilot valve. The lubricator on the left side furnishes lubrication for the same parts as explained for the Nathan lubricator.

The Boiler

The boiler is conical in form with an inside diameter at the first course of 86$\frac{3}{16}$ in. and an inside diameter at the third course of 100 in. It has a 30-in. steam space over the crown sheet. The barrel courses, welt strips and roof sheets are of silico-manganese steel which has a tensile strength of 70,000 lb. per sq. in. The inside dimensions of the firebox are 150$\frac{1}{16}$ in. by 96$\frac{3}{16}$ in., and the length of the combustion chamber is 72 in. There are five 4-in. arch tubes. The fuel is burned on Firebar grates fed by a Standard type BK stoker.

The side sheets and crown sheets are separate and are joined by welding. The inside throat sheet and combustion chamber are welded into the crown and side sheets. Flannery flexible staybolts are applied as follows: 166 in the throat sheet; 278 in the back head; 432 in the side sheets, and 656 in the crown sheet—a total of 1,532. These staybolts are of Lewis iron on six engines, Ewald iron on four engines, Burden iron on five engines, and Ulster iron on five engines. The rigid staybolts on each of five engines are of Lewis, Ewald, Ulster and Burden iron, respectively. All water-space rigid and flexible staybolts are hollow drilled. Seal welding is employed on both the inside and outside sheets at the mud-ring corners and at the junction of the longitudinal and circumferential barrel-course joints, according to the builder's practice.

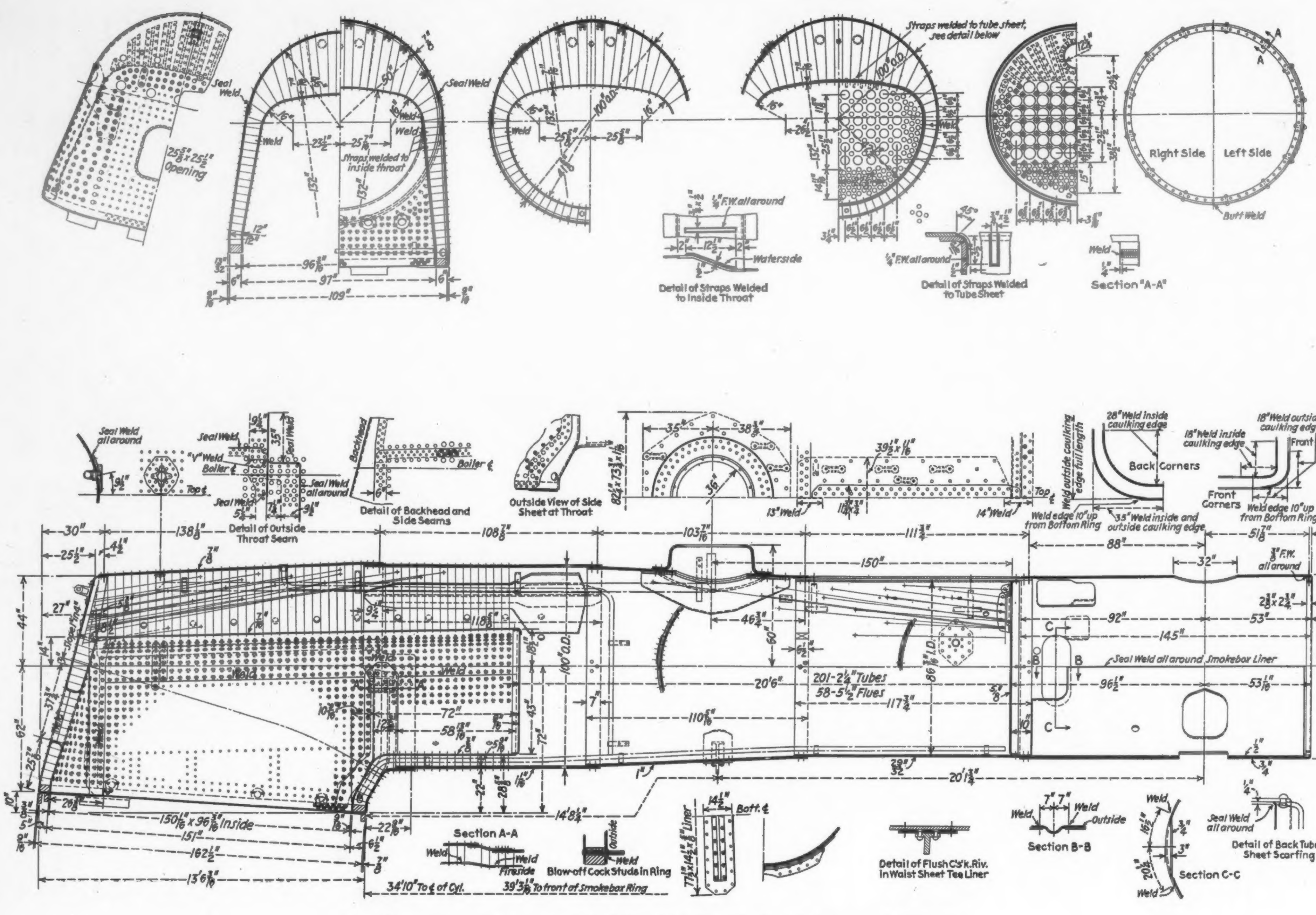


Details of the front section of the side rods

The locomotives have 201 tubes of 2¼ in. diameter and 58 hot-rolled seamless-steel 5½-in superheater flues. The length of flues and tubes is 20 ft. 6 in. The tubes have a heating surface of 2,415 sq. ft.; the flues, 1,703 sq. ft.; the firebox, 422 sq. ft.; the arch tubes, 57 sq. ft. The superheating surface is 1,473 sq. ft.

Each of the locomotives is equipped with one Nathan non-lifting injector, one Sellers exhaust steam injector, and Nathan 3-in. and Sellers 3-in. boiler checks, each of 10,000 gal. per hr. capacity, on the right and left side of the locomotive, respectively. The pipes to the check valves are led into recesses in the side of the smokebox sheets to assure unobstructed vision from the cab. The injector steam pipes on the right side are set down to the running board and under the jacket to improve the engineman's vision.

The locomotives are each equipped with an Elesco tangential steam dryer in the dome; a Franklin firedoor;



Cross-sections and elevation of the boiler of the Union Pacific 4-8-4 passenger locomotive

American arch brick; two Wiltbonco reflex type water glasses; Prime gage cocks; Hancock and Lukenheimer valves; Wilson blow-off cocks; two Nathan No. 2 drop plugs at the lowest point in the crown sheet; individual saturated-steam drypipe for the whistle, and American front-end throttle. The front end is the Master Mechanic type with the railroad company's standard exhaust pipes and 24-in. stack.

The boiler is supported between the No. 2 and 3 drivers and at the front and rear of the firebox by bearers with sliding shoes which float in oil. A cast bracket is bolted to a Tee, which is rigidly secured to a liner over the bearer, which is in turn attached to the boiler. A sheet-metal casing is attached to the bed, completely enclosing the shoe, and is oil-tight to retain the oil bath. The cover attached to the firebox support slides over the casing openings in the top of the cover.

The cab, as noted on the erecting drawing, is entirely supported from the locomotive boiler and not from the frames. The cab floor is supported by a separate casting which forms also the support for the stoker, grate shaker fulcrums and brake pedestal. The running boards are of 3/16-in. plate, perforated with 1-in. holes.

The Tenders

The tenders have cast-steel water-bottom underframes. with U-shaped tanks, each having a capacity of 20,000 gallons of water and 25 tons of coal. Five of the tenders are equipped with Buckeye six-wheel trucks, while the remaining 15 are equipped with Commonwealth six-wheel trucks, all fitted with SKF roller bearings. The engine-tender connections are Unit safety bars with Franklin type E radial buffer. At the rear end, the tenders are fitted with Miner A5XB draft gears, A. S. F. cast-steel coupler yokes, and National Malleable & Steel Casting Company swivel-butt couplers. The tanks have four manholes, with a wooden platform around each hole. Simplex unit-cylinder clasp brakes with double brake shoes are fitted on the trucks.

Partial List of Materials and Equipment on the Union Pacific 4-8-4 Type Locomotives

Locomotive bed casting	General Steel Castings Corp., Eddystone, Pa.
Staybolt iron, flexible stays	(6) Lewis Bolt & Nut Co., Minneapolis, Minn. (4) Ewald Iron Co., Louisville, Ky. (5) Burden Iron Co., Troy, N. Y. (5) Ulster Iron Works, Dover, N. J.
Staybolt iron, rigid stays	(5) Lewis Bolt & Nut Co., Minneapolis, Minn. (5) Ewald Iron Co., Louisville, Ky. (5) Burden Iron Co., Troy, N. Y. (5) Ulster Iron Works, Dover, N. J.
Flexible staybolts	Flannery Bolt Co., Bridgeville, Pa.
Fire brick	American Arch Co., Inc., New York
Fire door	Franklin Railway Supply Co., Inc., New York
Superheater, Type A	The Superheater Company, New York
Superheater flues	(5) Globe Steel Tubes Co., Milwaukee, Wis. (10) National Tube Co., Pittsburgh, Pa. (5) Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Stoker, Standard BK	Standard Stoker Co., Inc., New York
Grates, Firebar	Waugh Equipment Company, New York
Smokebox hinges, cast-steel, front	The Okadee Company, Chicago
Front-end throttle	American Throttle Co., Inc., New York
Boiler drop plug	Nathan Mfg. Co., New York
Boiler tubes	(5) Globe Steel Tubes Co., Milwaukee, Wis. (5) National Tube Co., Pittsburgh, Pa. (5-Electrunite) Steel & Tubes, Inc., Cleveland, Ohio (5) Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Washout plugs	(10) The Prime Manufacturing Co., Milwaukee, Wis. (10) Huron Mfg. Co., Detroit, Mich.
Lagging, pipe	Union Asbestos & Rubber Co., Chicago
Injector, non-lifting (one per locomotive)	Nathan Mfg. Co., New York
Exhaust steam injector (one per locomotive)	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Strainers for exhaust steam injectors	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Blow-off cocks with sludge remover	Wilson Engineering Corporation, Chicago
Feed pipe strainer	T-Z Railway Equipment Co., Chicago
Boiler check: Right side	Nathan Mfg. Co., New York
Left side	Wm. Sellers & Co., Inc., Philadelphia, Pa.
Water gages, reflex type, Wiltbonco (two per locomotive)	Nathan Mfg. Co., New York
Steam gage; Back pressure cut-off control gage; Safety valves	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Elesco tangential steam dryer	Superheater Company, New York
Lightweight valve, 12 in. diameter, with H-S Duplex sectional valve packing rings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Blower valve, stoker valve	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Valves	The Lunkenheimer Company, Cincinnati, Ohio
Gage cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Steam-heat equipment: Steam-heat valve and steam heat gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Pressure reducing valve	Vapor Car Heating Co., Inc., Chicago
Flexible joints between engine and tender	Franklin Railway Supply Co., Inc., New York
Flexible joints at rear end of tender	Vapor Car Heating Co., Inc., Chicago
Steam valves at turret	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Wovenstone on flexible connections between engine and tender and on exhaust steam pipe to Sellers injector	Union Asbestos & Rubber Co., Chicago
Fiberglass insulation in cab (except roof) and cab ventilators, side	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Clear vision window and cab storm windows	The Prime Manufacturing Co., Milwaukee, Wis.
Engineman's seat	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Bell Ringer	Railway Service and Supply Corp., Indianapolis, Ind.
Whistle	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Sanders	Viloco Railway Equipment Co., Chicago
Reverse gear: Ragonnet Type E	(15) Franklin Railway Supply Co., Inc., New York
Alco Type G	(5) American Locomotive Co., New York
Joints in steam line to reverse gear	Barco Mfg. Co., Chicago
Cylinder cocks	The Prime Manufacturing Co., Milwaukee, Wis.
Cylinder cock mufflers	Wilson Engineering Corporation, Chicago
Cylinder and piston-valve bushings	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Comb. bull and bronze "T" type packing rings	Locomotive Finished Material Co., Atchison, Kan.
Piston rod and valve-stem packing	Paxton-Mitchell Co., Omaha, Neb.
Commonwealth four-wheel Delta type truck	General Steel Castings Corp., Eddystone, Pa.
Cast-steel engine truck, four wheel, U. P. type	American Locomotive Co., New York
Driving wheels, Boxpok	
Enginetruck wheels, rolled	Standard Steel Works Co., Burnham, Pa.
Front trailer-truck wheels rolled	Standard Steel Works Co., Burnham, Pa.
Springs, Elliptic, Chrome-vanadium and others	American Locomotive Co., Railway Steel Spring Div., New York
Spring washers	National Malleable and Steel Castings Co., Cleveland, Ohio
Engine and trailer-truck roller bearings	SKF Industries, Philadelphia, Pa.
Driving-box roller bearings	The Timken Roller Bearing Company, Canton, Ohio
Unit type safety drawbar and radial buffer, type E	Franklin Railway Supply Co., Inc., New York
Lateral cushioning device	American Locomotive Co., New York
Lubricators, mechanical	(10) Nathan Mfg. Co., New York (10) Detroit Lubricator Co., Detroit, Mich.
Shoes and wedges, automatic compensator and snubber	Franklin Railway Supply Co., Inc., New York

Air pump packing	Union Asbestos & Rubber Co., Chicago
Air brake gage	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Brake indicating gage	U. S. Metallic Packing Co., Philadelphia, Pa.
Tender:	
Frame, cast steel water bottom	General Steel Castings Corp., Eddystone, Pa.
Trucks, cast steel; six-axle	(5) Buckeye Steel Castings Co., Columbus, Ohio (15) General Steel Castings Corp., Eddystone, Pa.
Wheels	(10) Standard Steel Works Co., Burnham, Pa. (10) American Steel Foundries, Chicago
Roller bearings	SKF Industries, Philadelphia, Pa.
Unit cylinder clasp brakes	American Steel Foundries, Chicago
Draft gear, A5XB spring type	W. H. Miner, Inc., Chicago
Coupler yoke, cast steel	American Steel Foundries, Chicago
Coupler, swivel but	National Malleable and Steel Castings Co., Cleveland, Ohio.
Uncoupling rigging, rotary, bottom operated, Imperial	Union Metal Products Co., Chicago
Train number indicator	The Adams & Westlake Co., Elkhart, Ind.
Headlight and generator	(15) The Pyle-National Co., Chicago (5-Sunbeam) General Electric Company, Schenectady, N. Y.
Automatic train control (cab signals)	Union Switch & Signal Co., Swissvale, Pa.

A Study, Based on Laboratory Results, of

The Locomotive Front End

Part II

By H. S. Vincent*

An investigation of the laws which govern the flow of steam and gas in a locomotive front end—The author discusses the feasibility of reducing back pressure in locomotive cylinders

Gas Flow

As stated in Part I of this article, published in the January issue, the main purpose of the locomotive front-end mechanism is to move the maximum quantity of gases of combustion across the locomotive heating surfaces with the minimum expenditure of energy.

In estimating the weight of gases to be moved in unit time, it is necessary to have the following data: (*a*) Weight of fuel fired per unit of time, usually, lb. per sq. ft. of grate surface per hr.; (*b*) ratio of fuel burned to fuel fired; (*c*) weight of gas generated per lb. of fuel fired; and (*d*) boiler efficiency. The method of calculating items (*b*), (*c*) and (*d*) is fully discussed by the writer in an earlier paper,[5] so it need not be repeated.

In relating the steam flow M_o through the nozzle to the unit weight of fuel fired G

$$M_o = \frac{K\,(mG - nG^2)\,R_o\,C_f}{3600\,H_2} \qquad (15)$$

[5] "Heat Transmission in Locomotive Boilers," by H. S. Vincent, *Railway Mechanical Engineer*, vol. 109, May, June and August, 1935, pages 180, 228 and 335, respectively.

The coefficient C_f was determined by plotting the curve which most nearly conforms to the test data. For locomotive *A*, this curve is illustrated by Fig. 16. Curves for the other seven locomotives were constructed in a similar manner. The coefficient C_f is the proportion of the heat in the fuel imparted to the steam which appears at the nozzle exit. For locomotive *A*, $C_f = 0.87$. For all the tests discussed, it ranges from 0.83 to 0.89.

The quantity H_2 in equation (15) is the average value of the enthalpy of the steam at the nozzle exit. It apparently bears a straight-line relation to the unit weight

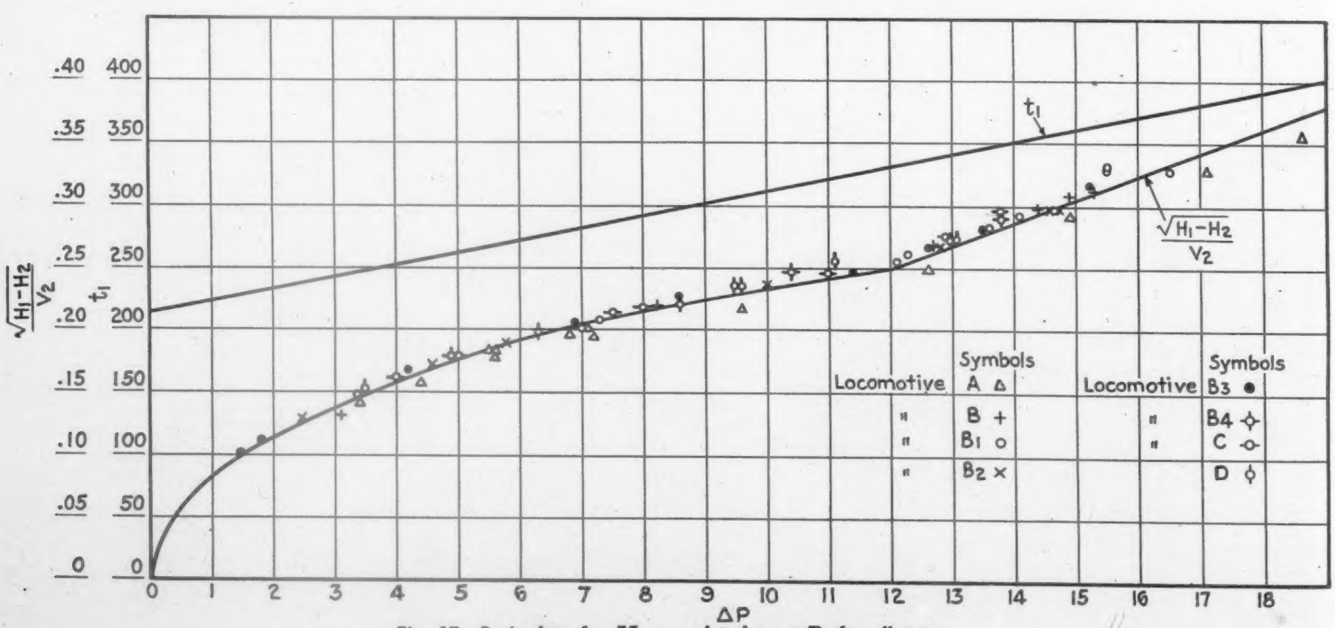


Fig. 15—Basic data for M_t, as related to $\triangle P$, for all tests

of coal fired G. The value of H_2, as determined for locomotive A, is shown in Fig. 17 where

$$H_2 = 1176 + 0.0857G \qquad (16)$$

The weight of gas flowing across the heating surfaces per pound of steam exhausted from the nozzle, is

$$C_s = \frac{C_g\ C_b\ G\ R_o}{3600\ M_o} = \frac{W_f\ G\ R_o}{3600\ M_o} \qquad (17)$$

The weight of gas per second flowing over the heating surfaces is

$$W_g = M_o\ C_s \qquad (18)$$

The value of C_s, as related to M_o, for the eight locomotives being discussed is shown in Figs. 5A to 12A,

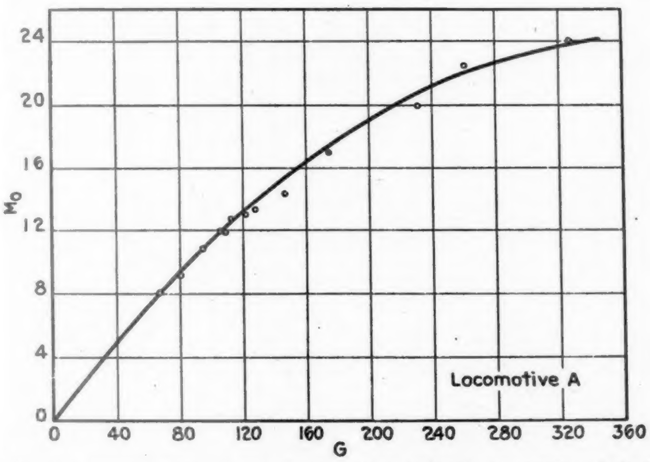


Fig. 16—Mean steam flow per second as related to weight of fuel fired per square foot of grate surface per hour for locomotive A

inclusive. The relation between W_g and M_o is shown in Figs. 5B to 12B, inclusive. It will be observed that the smooth curve for W_g very closely approximates the actual gas flow as determined from the tests and indicated by the small circles.

The method of assembling the data for the curves C_s and W_g is illustrated by Table VI, applying to locomotive A.

The relation between W_g and ΔP is shown by Figs. 5C to 12C, for all the tests being discussed.

The relation between M_o and $\sqrt{\Delta P}$, between M_o and W_g, and between W_g and ΔP, for the eight locomotives, are shown in Figs. 18, 18B and 18C, respectively. It will be seen from Fig. 18, that for all values of $\sqrt{\Delta P}$, the M_o curves fall in the same order as the nozzle area. In Fig. 18B, the gas flow per second from zero to M_o = 12 is almost identical for locomotives A and D, although the nozzle areas and smokebox arrangements of these locomotives are very dissimilar. By following the vertical lines through to their intersection with the M_o curves in Fig. 18 it will be seen that although the same weight of gas is being moved, the value of ΔP, required to move it, is very different.

The advantage derived from improvement in front-end design is well illustrated in Fig. 18C by comparing the curves for locomotives B, B_1 and B_2. Reference to Fig. 1 will show that locomotive B is equipped with the Master Mechanics front-end arrangement including a Goodfellow nozzle having an area of 0.25 sq. ft. Locomotive B_1 has the same smokebox arrangement but is equipped with a six-point star nozzle having an area of 0.28 sq. ft. At ΔP = 12, the gas moved per second by locomotive B_1 is over 18 per cent greater than for locomotive B. A further improvement is effected by applying the smokebox arrangement shown in Fig. 1 for locomotive B_2, and using a six-point star nozzle having an area of 0.3335 sq. ft. At the same pressure, the gas moved by locomotive B_2 is 27.6 per cent greater than for locomotive B. It must be remembered that overwise than mentioned above, locomotives B, B_1 and B_2 are identical in design.

In the model tests previously referred to,[1*] when using a circular nozzle 1½ in. in diameter, the air flow per pound of steam as tabulated in Appendix G, Bulletin No. 256,[1] varied directly as the weight of steam emitted through the nozzle. This is shown in Fig. 19B. It cannot be expected that in the actual locomotive a similar relation will exist. In the model test, the air moving

Table VI—Calculated Data for Plotting Fig. 16

1 G	2[a] C_s	3 H_2	4 mG-nG^2	5[b] W_f	6[c] M_o	7 C_f	8[d] W_g
20	2.210	1177.5	12.85	14.52	2.55	0.87	5.63
40	2.185	1179.3	25.00	13.92	4.95	0.87	10.81
60	2.158	1180.1	36.45	13.33	7.21	0.87	15.55
80	2.130	1182.5	47.20	12.77	9.33	0.87	19.87
100	2.100	1184.2	57.24	12.20	11.31	0.87	23.75
120	2.070	1186.0	66.60	11.67	13.14	0.87	27.20
140	2.045	1187.9	75.25	11.13	14.80	0.87	30.28
160	2.016	1189.6	83.20	10.60	16.35	0.87	32.95
180	1.990	1191.2	90.45	10.09	17.74	0.87	35.30
200	1.960	1193.0	97.00	9.59	19.00	0.87	37.25
220	1.936	1194.7	102.80	9.10	20.10	0.87	38.90
240	1.912	1196.2	108.00	8.62	21.10	0.87	40.40
260	1.882	1198.1	112.30	8.16	21.90	0.87	41.20
280	1.849	1200.0	116.20	7.70	22.61	0.87	41.82
300	1.826	1201.9	119.20	7.26	23.19	0.87	42.30
320	1.797	1203.8	121.60	6.83	23.60	0.87	42.41
340	1.773	1205.6	123.30	6.41	23.88	0.87	42.30

Notes: [a] See equation (17). [b] See equation (25). [c] See equation (8). [d] See equation (18). For definition of the terms in the column headings and their units, see Table III.

into the smokebox was limited only by a predetermined and constant resistance. In a locomotive, the gas supply is subject to a number of limiting factors, the value of which is constantly changing.

The air flow as determined on the model, for a series of circular nozzles, at various increments of P_s and with an identical smokebox arrangement, is taken from the Table 17, Appendix D, Bulletin No. 256.[1] These

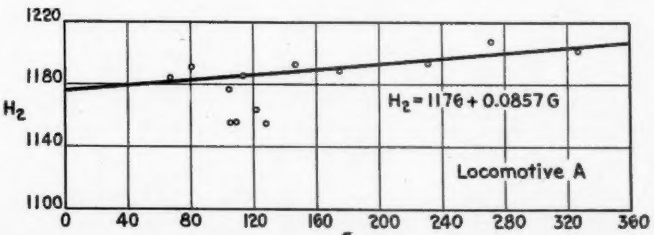


Fig. 17—Mean enthalpy of exhaust steam at nozzle exit as related to weight of fuel fired per square foot of grate surface per hour for locomotive A

data have been assembled in Fig. 20 in which the hourly air flow is shown in relation to the nozzle area. It will be seen from this exhibit that in these tests the air flow for all values of P_s varies as the cube root of the nozzle area. Having this law established, it is possible to assess the relative effectiveness of different constructions by direct comparison with the standard.

Fig. 6 of Bulletin No. 274 [1] gives the results of a test with a four hole "pepper-box" type of nozzle, having the same area as the 1½-in. circular nozzle and using the Master Mechanics standard front-end construction. At P_s = 8, the weight of air moved per hour with the pepper-box nozzle was 5,250 lb. or 19.8 per cent greater than with the equivalent circular nozzle operating under similar conditions. When the same pepper-

* Footnotes 1, 2, 3 and 4 were published with Part I of this article in the January issue.

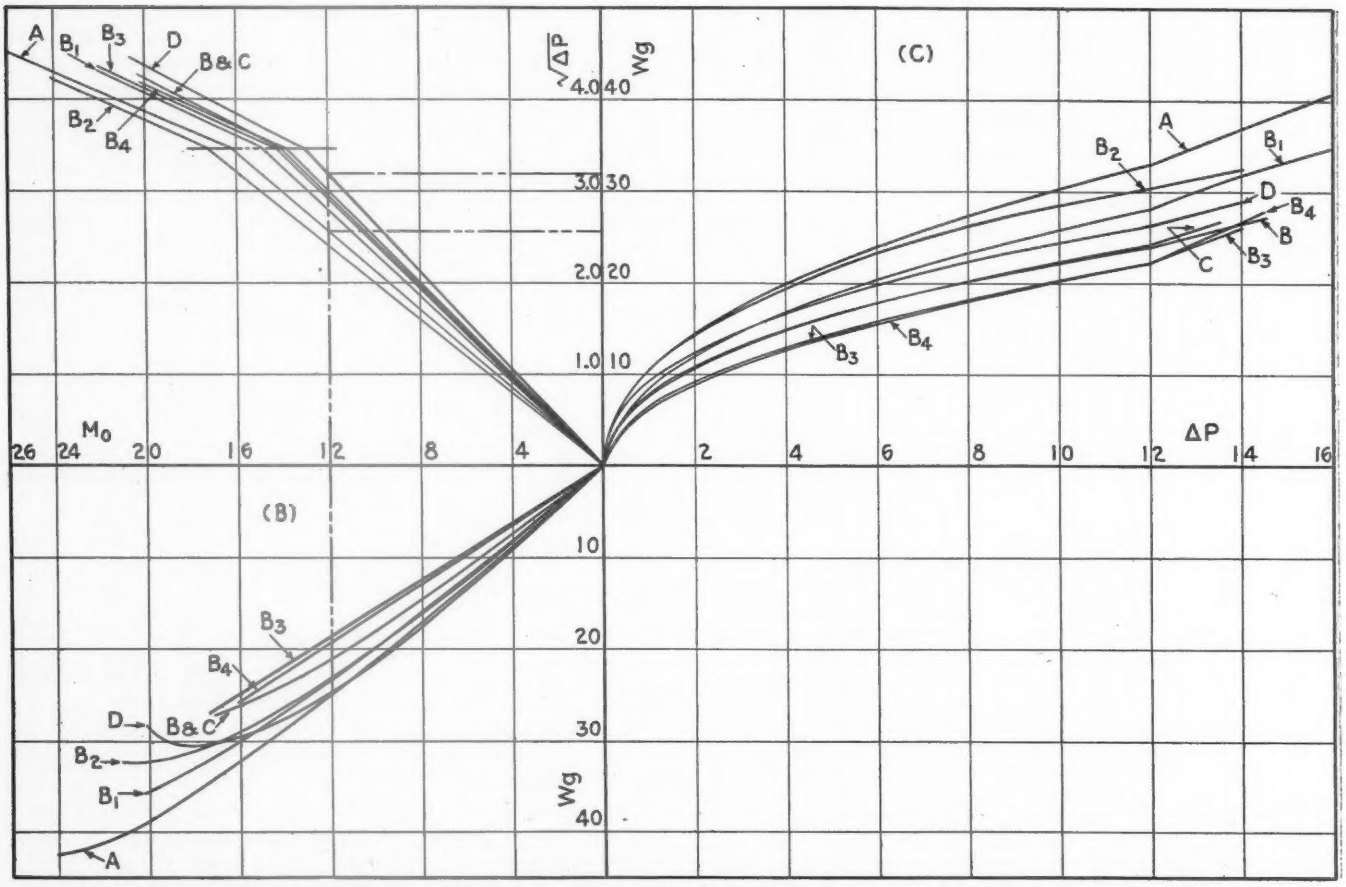


Fig. 18—Steam flow per second as related to ΔP, gas flow per second as related to steam flow, and gas flow as related to ΔP for the eight locomotives

box nozzle was applied in conjunction with a gyratory spark arrestor, arrangement *GB*, the increase over the circular nozzle and standard front-end arrangement was 27.6 per cent, of which 19.8 per cent was due to the design of the nozzle and 7.8 per cent to the spark arrester. These percentages are easily determined from Fig. 20.

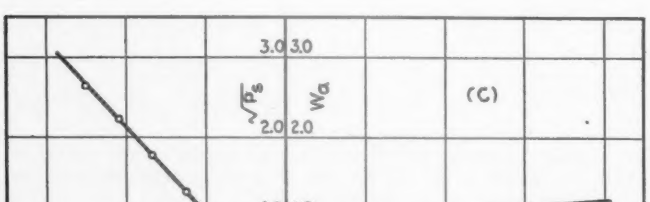


Fig. 19—Steam flow per second as related to P_S, air flow per pound of steam, air flow per second, and gas flow as related to P_S for Young's tests of model Master Mechanics front end with a 1½-in. circular nozzle

In the test of a six-hole pepper-box nozzle having an area of 1.841 sq. in., employing the *GB* spark arrester, the air moved per hour at $P_s = 8$ was 5,432 lb. or 22 per cent more than an equivalent round nozzle of the same area. It was therefore less efficient than the nozzle with four holes.

A star-shaped nozzle having an area of 1.959 sq. in. was tested using the *GB* arrangement. The air moved per hour at $P_s = 5$ was 4,205 lb., or 6.7 per cent more than for an equivalent round nozzle with Master Mechanics arrangement.

It is evident from Fig. 20 that increasing the area of a nozzle has the effect of moving a greater weight of air for any given value of ΔP or P_s. This, however, involves an increase in the weight of steam flowing through the nozzle. In Fig. 21 is shown the weight of air moved per hour, as related to P_s, for the various sizes of circular nozzles tested by Young.[1] In this figure is indicated, by the dashed curved lines, the effect of flowing constant weights of 1,300 and 1,550 lb. of steam per hr. through the nozzle. As the nozzle is increased in area, the weight of air moved decreases. This exhibit explains the reason for the common practice of reducing the nozzle area to make a locomotive steam better. It is, however, always done at the expense of higher back pressure.

It has been proved by Fig. 20 that the equation

$$W_a \propto \sqrt[3]{A_2} \quad \text{..................................(19)}$$

accurately represents the model tests. There is apparently no reason why the equation cannot be applied to the actual locomotive by substituting W_g for W_a. This has been done as shown in Fig. 22, which applies to the eight locomotives being discussed. Inasmuch as these locomotives embody a variety of nozzle shapes and

smokebox arrangements, it is necessary to select one set of conditions as a basis for calculating the curves of ΔP. In Fig. 22, locomotive B has been used as a base, since it represents the present standard front-end construction, viz, Master Mechanic arrangement of drafting apparatus, Goodfellow nozzle having an area of 0.25 sq. ft., and with the superheater damper eliminated as shown in Fig. 1.

Locomotive B will first be compared with locomotive B_1. Both locomotives have exactly the same smokebox

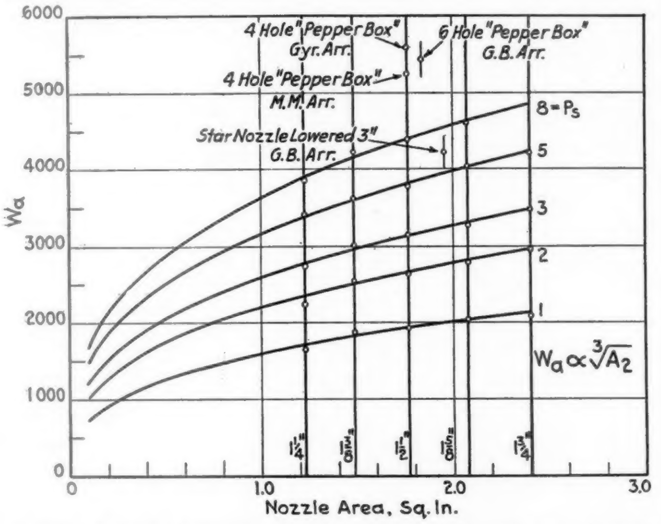


Fig. 20—Relation between the weight of air moved per hour and nozzle area (data taken from Table 16 of Appendix C and Table 17 of Appendix D, Bulletin No. 256 Engineering Experiment Station, University of Illinois.)

arrangement but B_1 is equipped with a six-point star nozzle having an area of 0.28 sq. ft. At $\Delta P = 12$, the gas moved by locomotive B_1 is 18 per cent greater than for locomotive B. Of this increase, 4.5 per cent is due to the increased area of the nozzle and 13.5 per cent to its improved contour. At $\Delta P = 10$, locomotive B_1 moved 16.3 per cent more gas than locomotive B, of which 4.2 per cent is due to increased area and 12.1 per cent to nozzle contour. At $\Delta P = 8$, the percentages of increase are 4.8 and 10.2, respectively. These are readily determined by inspection of Fig. 22.

A similar comparison will next be made between locomotives B_1 and B_2. The latter has an improved smokebox arrangement with a six-point star-nozzle having an area of 0.3335 sq. ft., as illustrated in Fig. 1. At $\Delta P = 12$, the weight of gas moved by locomotive B_2 is 8.2 per cent greater than for B_1; of this, 2.2 per cent is due to increased nozzle area and 6.0 per cent to improved front-end construction. At $\Delta P = 10$, the gas moved by locomotive B_2 is 10.5 per cent greater than for B_1; of this, 4.3 per cent is chargeable to increased nozzle area and 6.2 per cent to improved front-end construction. At $\Delta P = 8$, the percentages of increase are 7.3 and 6.4, respectively.

It will be seen from column 19 of Table II, for locomotive B_2, that the weight of gas passing over the heating surfaces decreases with increasing fuel consumption. This is reflected in the low value of ΔP found in Fig. 22, for this locomotive.

Comparison has now been made between three locomotives, identical in general design and differing only in the drafting apparatus. The next comparison is between the very dissimilar locomotives B_1 and A, the smokebox arrangements for which are shown in Fig. 1. At $\Delta P = 12$, the weight of gas moved per hour by locomotive A was 17 per cent greater than for locomotive B_1. The proportion of the increase due to the larger nozzle is 4.7 per cent. The improved front end and lower resistance to gas flow accounts for the remaining 12.3 per cent. Probably about half of this is due to the front-end arrangement.

At $\Delta P = 10$ and also at $\Delta P = 8$, the gas moved by locomotive A was 18 per cent greater than for B_1; of this, the nozzle accounted for 4.8 per cent and 4.5 per cent, respectively.

Locomotives B, B_3 and B_4, as previously stated, are practically identical in design, having the same smokebox arrangement except that locomotives B_3 and B_4 have a superheater damper and larger nozzles as indicated in Table IV. The position of the small circles representing ΔP, for locomotives B_3 and B_4, in Fig. 22, fall below the curves based on locomotive B. This is caused by the resistance to gas flow offered by the superheater damper. At $\Delta P = 12$, the reduction in the gas flow from this cause is from 8 to 9 per cent.

The comparisons given here illustrate what can be accomplished in the reduction of ΔP by improvement in nozzle and front-end design.

Smoke Stack

Young and other experimenters have shown that the correct diameter of the smoke stack is essential to the proper functioning of any front-end arrangement. In the report of the A.A.R. Committee,[2] referred to previously, it is recommended that the minimum area of the stack be 25 per cent of the net tube and flue area and that the area of the nozzle be determined from the stack dimensions. It would seem that this is approaching the

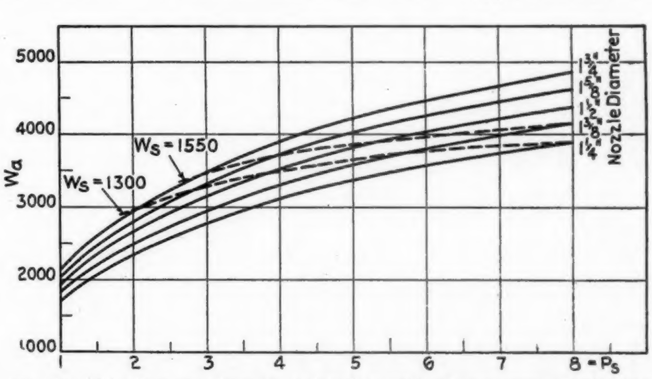


Fig. 21—Air flow per hour as related to exhaust pressure—Basic data was obtained from the source mentioned in Fig. 20

problem from the wrong direction, that is, the area of the nozzle should be first determined.

To fix the proper stack diameter for any locomotive, it is essential to know approximately the flare of the steam jet, or the angle it makes with the vertical center of the nozzle. The A.A.R. report[2] gives this angle as 6 deg. for bridged nozzles when ΔP ranges from 8 to 10. The tests made by Young [1] with round nozzles indicate that the flare of the jet varies with P_s. For the 1½-in. nozzle and typical locomotive stack, the flare was found to be 7 deg. 8 min. when $P_s = 1$ on the model, and was 6 deg. 35 min. when $P_s = 5$ on the model.

Assuming that the model test is more nearly correct, then

$$a = 6.58 + 0.029 \Delta P \qquad (20)$$

It is not clear why the application of a bridge should make a difference in the flare of the jet, since the flare is conditioned by the lip of the nozzle, which in practically all cases forms an angle of 90 deg. with the vertical.

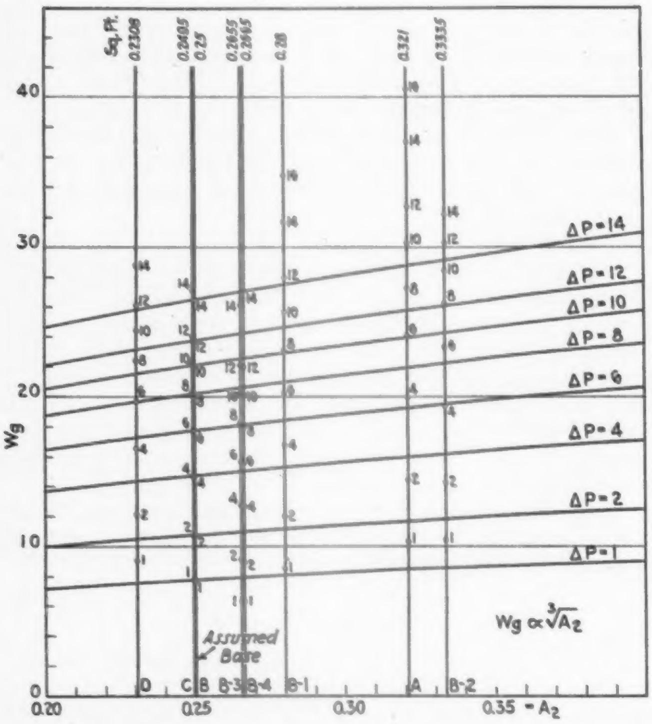


Fig. 22—Relation between gas flow per second Wg and nozzle area A_2 for the eight locomotive tests

(Circles represent the actual variation between ΔP and W_g, as developed in the tests.)

The point where the jet impinges on the periphery of the stack is shown in Fig. 1 for each of the arrangements, assuming a jet flare of 6 deg. It will be noted that the point of impingement, with reference to the top of the stack, varies greatly. The recommendation of the A.A.R. Committee,[2] that the sealing point of the jet be 12 in. below the top of the stack, seems reasonable where circular nozzles are used. It is evident that the area between the jet and the stack, below the sealing point, should be as great as practicable in order to give the jet its maximum entraining surface.

If L = the distance from the nozzle to the point of seal in a straight stack, D = the diameter of the stack and d = the diameter of the nozzle, then

$$D = d + (2L \tan a) \quad \text{(21)}$$

For tapered stacks it is more convenient to plot the required diameter D_1 at the point of impingement of the jet. For other than circular nozzles, equation (21) can be used by making the maximum dimension of the nozzle = d.

Reference to Fig. 23 will show that some allowance must be made in the calculation of the dimension L when other than a circular nozzle is used. If a section

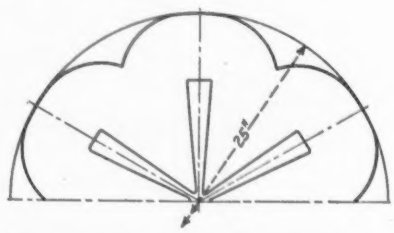


Fig. 23—Development at the point of impingement in a 25-in. stack of the jet from a six-point star nozzle

is taken through the jet at the point where it should impinge on the stack, in accordance with equation (21), it will be seen that for the star-type nozzle there are six points in the periphery of the jet which theoretically do not touch the stack at the dimension L, but which must be carried to a higher plane before contacting the stack. Therefore, for other than circular nozzles it is desirable to fix the normal point of impingement at a distance of from 24 in. to 30 in. from the top of the stack.

Part III of this article will appear in a subsequent issue.

Annual Report of Bureau of

Locomotive Inspection

Locomotives inspected, the number ordered from service and number of defects found increase, but the per cent found defective remained the same as for the preceding three years —Accidents and deaths increase over those reported in 1936

The annual report of the Bureau of locomotive inspection submitted by John M. Hall, chief inspector, which covers the fiscal year ended June 30, 1937, shows an increase over 1936 in the number of locomotives inspected, the number found defective, the number ordered out of service, and the number of defects found; however, the percentage of locomotives inspected which were found defective remained at 12 per cent as for the preceding three years. There was an increase of 9.6 per cent over 1936 in the number of locomotives ordered from service because of defects which rendered the locomotive immediately unsafe.

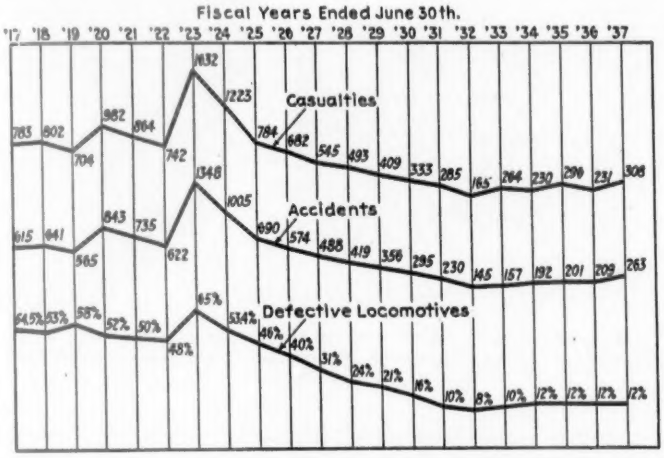
In addition to the accidents shown in the tables and otherwise referred to in this report, there was reported to the bureau a total of 87 accidents in which four employees were killed and 83 employees injured in falls while in the performance of their duties on locomotives. None of these falls could be attributed to any features encountered in connection with the condition of locomotives, it being apparent in each instance that the falls were caused by inattention or sudden illness on the part of those killed and injured. These accidents do not come within the scope of the locomotive inspection law but are mentioned here in order to emphasize the necessity of alertness on the part of all persons employed on or about locomotives.

Steam Locomotives

During the fiscal year ended June 30, 1937, the number of steam locomotives inspected totaled 100,033 of

which 12,402 or 12 per cent were found defective and 934 were ordered out of service, the latter figure representing an increase of 9.6 per cent from the preceding year. In 1936, there were 97,329 locomotives inspected, of which 11,526 were found defective and 852 were ordered out of service. In the year ending June 30, 1935, a total of 94,151 locomotives were inspected of which 11,071 were found defective and 921 were ordered out of service. The total number of defects shown in the last three reports were 44,941 in 1935, 47,553 in 1936 and 49,746 in 1937.

The total number of accidents caused by failure of



Relation of defective steam locomotives to accidents and casualties resulting from locomotive failures

some part of the steam locomotive, including boiler or tender was 201 in 1935, 209 in 1936 and 263 in 1937. The number of persons killed from such accidents were 29 in 1935, 16 in 1936 and 25 in 1937; the deaths in 1937 represent an increase of 52.2 per cent over the number of persons killed in 1936.

There was an increase of 54 in the number of accidents occurring in connection with steam locomotives,

Condition of Inspected Steam Locomotives and Their Relation to Accidents and Casualties*

Fiscal year ended June 30	Per cent of locomotives inspected found defective	Number locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1912	65.7	3,337	856	91	1,005
1915	44.4	2,027	425	13	467
1925	46.0	3,637	690	20	764
1926	40.0	3,281	574	22	660
1927	31.0	2,539	488	28	517
1928	24.0	1,725	419	30	463
1929	21.0	1,490	356	19	390
1930	16.0	1,200	295	13	320
1931	10.0	688	230	16	269
1932	8.0	527	145	9	156
1933	10.0	544	157	8	256
1934	12.0	754	192	7	223
1935	12.0	921	201	29	267
1936	12.0	852	209	16	215
1937	12.0	934	263	25	283

* The original act applied only to the locomotive boiler, but was amended in 1917 to include the entire locomotive and tender.

an increase of 9 in the number of persons killed, and an increase of 68 in the number of persons injured compared with the previous year. The chart shows the relation between the percentage of defective steam locomotives and the number of accidents and casualties resulting from failures thereof, and illustrates the effect of operating locomotives in defective condition.

There was an increase of one in the number of accidents, an increase of 9 in the number of persons killed, and an increase of 3 in the number of persons injured as a result of boiler explosions or crown-sheet accidents as compared with the previous year. The foregoing includes four deaths and two injuries that occurred as a result of a derailment followed by an explosion when the locomotive fell from a trestle and alighted on a highway 96 ft. below the level of the rails. The boiler was torn apart at the back-end connection seam and the cylindrical part of the boiler was hurled upward and forward; it struck the track 400 ft. ahead of the point of explosion and rebounded and came to rest 350 ft. further on, or a distance of 750 ft. from the point where the explosion occurred. The back end of the boiler was blown backward 50 ft. and parts of the locomotive and boiler were scattered over a radius of 1,000 ft.

In another explosion, caused by overheating the crown sheet due to low water, the boiler was blown 323 ft. forward and parts of the wreckage were scattered over a radius of 800 ft. This boiler was equipped with only one water glass, the top cock of which was found closed and the valve stem bent in such a manner as to indicate that it must have been closed prior to the explosion. Upon test on another locomotive one of the four safety valves did not open and when it was disassembled it was found that a piece of steel tubing had been substituted for the spring. A sworn report had been made at the last quarterly inspection 38 days before the accident that showed all four safety valves had been properly set at that time.

Boiler and appurtenance accidents other than explosions resulted in the death of 2 persons and the injury of 60 persons.

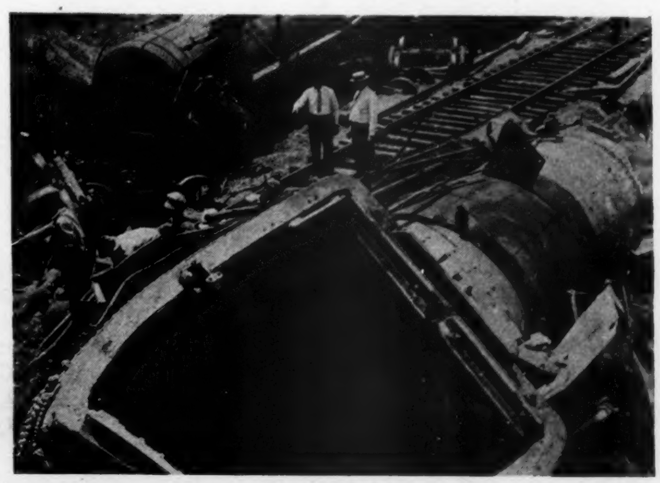
Extension of Time for Removal of Flues

Applications for extensions of time for removal of flues as provided for in rule 10 totaled 679. Of these, 50 were rejected, 41 were given extensions for a shorter time than requested, 35 were granted after defects found were repaired, 10 applications were canceled, and 543 extensions were granted for the full periods requested.

Locomotives Other Than Steam

There was an increase of three in the number of accidents occurring in connection with locomotives other than steam and an increase of five in the number of persons injured as compared with the previous year. No deaths occurred in either year.

During the fiscal year ended June 30, 1937, 3,615 locomotives other than steam were reported of which 328,



Low water caused this boiler explosion—The force of the explosion hurled the boiler forward 257 ft. from where it rebounded onto the track 57 ft. further on at which point it was rammed and pushed 493 ft. further by the running gear which had remained on the track

Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered From Service

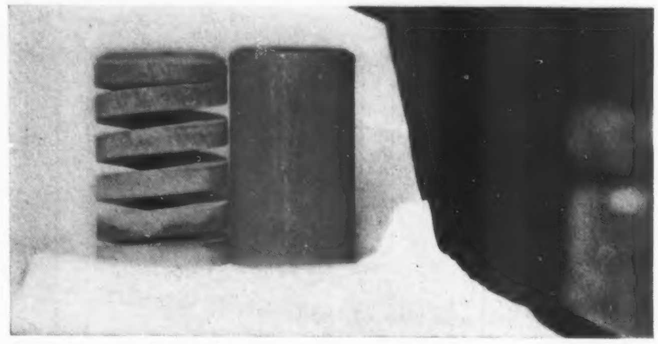
Parts defective, inoperative or missing, or in violation of rules	Year ended June 30— 1937	1936	1935	1934	1933	1932
1. Air compressors	766	740	733	660	474	417
2. Arch tubes	105	74	74	127	51	54
3. Ash pans and mechanism	80	79	94	87	40	69
4. Axles	10	13	10	6	21	13
5. Blow-off cocks	201	236	283	289	210	144
6. Boiler checks	382	356	413	407	293	214
7. Boiler shell	347	383	395	372	296	220
8. Brake equipment	2,322	2,480	2,449	2,326	1,696	1,645
9. Cabs, cab windows and curtains	1,807	1,638	1,273	1,342	1,183	851
10. Cab aprons and decks	466	450	368	343	309	262
11. Cab cards	145	166	142	129	121	162
12. Coupling and uncoupling devices	74	65	73	54	67	85
13. Crossheads, guides, pistons and piston rods	1,160	1,056	1,086	1,100	773	763
14. Crown bolts	76	63	75	77	67	50
15. Cylinders, saddles and steam chests	2,206	1,717	1,547	1,491	1,084	841
16. Cylinder cocks and rigging	729	605	627	654	374	376
17. Domes and dome caps	101	114	94	105	76	45
18. Draft gear	522	513	423	401	318	325
19. Draw gear	560	451	414	480	357	371
20. Driving boxes, shoes, wedges, pedestals and braces	1,637	1,712	1,573	1,472	1,080	821
21. Firebox sheets	371	295	343	356	246	235
22. Flues	225	178	173	203	150	120
23. Frames, tailpieces and braces, locomotive	1,053	997	1,006	951	669	611
24. Frames, tender	120	113	124	128	80	86
25. Gages and gage fittings, air	261	257	275	212	145	156
26. Gages and gage fittings, steam	324	350	320	289	258	214
27. Gage cocks	538	579	480	384	388	330
28. Grate shakers and fire doors	470	400	394	404	245	288
29. Handholds	510	502	464	377	363	382
30. Injectors, inoperative	38	40	39	33	20	31
31. Injectors and connections	2,020	2,085	2,035	1,909	1,357	1,168
32. Inspections and tests not made as required	9,638	9,005	8,344	8,173	6,358	3,801
33. Lateral motion	446	404	389	351	269	237
34. Lights, cab and classification	90	78	81	79	76	55
35. Lights, headlight	313	251	257	218	169	119
36. Lubricators and shields	254	255	191	215	157	119
37. Mud rings	272	237	241	247	232	166
38. Packing nuts	487	508	527	491	419	402
39. Packing, piston rod and valve stem	1,393	1,133	906	833	592	444
40. Pilot and pilot beams	133	178	152	174	123	145
41. Plugs and studs	238	236	167	242	151	176
42. Reversing gear	492	463	414	390	254	202
43. Rods, main and side, crank pins and collars	2,348	2,093	1,826	1,670	1,327	1,256
44. Safety valves	132	125	100	103	53	63
45. Sanders	653	678	779	697	376	289
46. Springs and spring rigging	3,172	3,008	2,765	2,854	2,122	1,851
47. Squirt hose	133	134	113	107	93	96
48. Stay bolts	276	279	140	285	219	181
49. Stay bolts, broken	542	520	512	455	368	552
50. Steam pipes	446	526	463	489	338	285
51. Steam valves	165	227	212	267	193	143
52. Steps	678	615	640	567	498	622
53. Tanks and tank valves	1,009	877	913	862	600	587
54. Telltale holes	79	127	102	93	90	108
55. Throttles and throttle rigging	909	760	733	639	448	434
56. Trucks, engine and trailing	785	861	811	898	664	648
57. Trucks, tender	1,018	1,108	1,120	918	747	766
58. Valve motion	798	824	799	784	640	520
59. Washout plugs	598	714	679	776	623	599
60. Train-control equipment	12	6	4	8	4	13
61. Water glasses, fittings and shields	1,049	1,118	951	907	716	676
62. Wheels	803	790	697	734	580	603
63. Miscellaneous—signal appliances, badge plates, brakes (hand)	759	608	563	572	423	325
Total number of defects	49,746	47,453	44,491	43,271	32,733	27,832
Locomotives reported	48,025	49,322	51,283	54,283	56,971	59,110
Locomotives inspected	100,033	97,329	94,151	89,716	87,658	96,924
Locomotives defective	12,402	11,526	11,071	10,713	8,388	7,724
Percentage of inspected found defective	12	12	12	12	10	8
Locomotives ordered out of service	934	852	921	754	544	527

or 9 per cent, were found defective, and 24 were ordered from service. This compares with 3,118 locomotives inspected during the previous year of which 252, or 8 per cent, were found defective and 11 were ordered from service. In 1933, 1934 and 1935, 1,368, 1,436 and 1,620 locomotives were inspected, respectively, of which 74, 69 and 146, respectively, were found defective and 3, 4, and 5, respectively, were ordered from service.

Recommendations

In accordance with the provisions of Section 7 of the locomotive inspection act the following recommendations, with reasons therefor, are made for the betterment of the service:

1. All steam road locomotives should be equipped with a suitable water column to which shall be attached three gage cocks and one water glass with not less than 6 in., preferably 8 in., clear reading, and one additional water glass with not less than 6 in., preferably 8 in., clear reading, located on the left side or back head of the boiler. The water glasses are to be so located, constructed, and maintained that they will register the approximate general water level in the boiler under all conditions of service and show a corresponding level



This piece of steel tubing was substituted for a safety-valve spring, similar to the one shown at the left, in a locomotive which later exploded

within 1 in. and be so located, constructed, and maintained that the engineer and fireman may under all conditions of service have an easy and clear view of the water in the glass from their respective and proper positions in the cab.

2. Cabs of all steam locomotives not equipped with front doors or windows of such size as to permit of easy exit should have a suitable stirrup or other step and a horizontal handhold on each side, approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it—handholds and steps or stirrups to be securely attached with bolts or rivets; the distance between the step and handhold to be not less than 60 in. nor more than 72 in.

3. All steam locomotives should be equipped with a brake-pipe valve, similar to the conductor's valve used in passenger-train cars and caboose cars, at the rear of the cab or the front end of the tender, to enable the brakes to be applied in the event the enginemen are, from any cause, prevented from applying the brakes in the usual manner.

4. The condemning limit for slid flat spots on wheels 36 in. or less in diameter on road locomotives should be reduced to 1 in., and such wheels should not be continued in service if out of round 1/16 in. or more in an arc having a length of 12 in. Pounds and vibrations set up by flat spots and wheels out of round cause loosening and failure of truck parts and are destructive to other parts of equipment and track, especially under present-day operating conditions when the speed of practically all trains has been greatly increased.

5. Safety glass should be used in all front cab doors and windows and in all cab storm windows. The use of ordinary glass in the front windows and in storm windows constitutes an unnecessary hazard to enginemen and others who may be riding in the cab, as is evidenced by an increasing number of injuries caused by the breaking and shattering of glass from these windows. It is therefore recommended that installation of safety glass be made mandatory in all front cab doors and windows and in all cab storm windows.

Passenger Cars Air-Conditioned During 1937

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators: No.	Generators: Capacity Kw.	Generators: Type of Drive	Generators: Type of Mounting	Storage Batteries: Make	Storage Batteries: Amp.-Hr. Capacity	Outside Power Supply*
A. T. & S. F.	2	Chair	St. ejec.	Safety C. H. & L.	....	Water	2	4	Flat belt	Truck	Exide	850	....
	6	Chair	St. ejec.	Safety C. H. & L.	....	Water	2	4	Flat belt	Truck	Exide	850	....
	3	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	7½	Flat belt	Body	Exide	850	....
	30	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	7½	Flat belt	Body	Exide	850	....
	4	Diners	St. ejec.	Safety C. H. & L.	....	Water	2	4	Flat belt	Truck	Exide	850	....
	11	Diners	St. ejec.	Safety C. H. & L.	....	Water	1	7½	Flat belt	Body	Exide	850	....
	1	Cafe-Obs.	St. ejec.	Safety C. H. & L.	....	Water	2	4	Flat belt	Truck	Exide	850	....
	6	Comb.	St. ejec.	Safety C. H. & L.	....	Water	1	7½	Flat belt	Body	Exide	850	....
	7	Lounge	St. ejec.	Safety C. H. & L.	....	Water	1	7½	Flat belt	Body	Exide	850	....
	5	Sleepers	St. ejec.	Safety C. H. & L.	....	Water	1	7½	Flat belt	Body	Exide	850	....
A. C. L.	8	Diners	Elec.-mech.	Frigidaire	Motor	Freon	2	10	Flat belt	Body	Exide	1,000	•
	16	Coaches	St. ejec.	Safety C. H. & L.	....	......	1	10	Flat belt	Body	Edison	600	....
	10	Diners	St. ejec.	Safety C. H. & L.	....	......	1	10	Flat belt	Body	9 Edison 1 Exide	600 850	....
B. & O.	11	Comb.	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide, Edison, Gould, K. W. and U. S. L.	1,000	....
	2	Diner	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Edison	1,000	....
	1	Obs.-Lounge	Electro-mech.	B. & O.-York	Motor	Freon	2	1-6 1-7½	Flat belt Flat belt-gear	Body	Exide	1,000	....
	1	Obs.-Lounge	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Gould	1,000	....
	2	Chair	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide and Gould	1,000	....
	3	Buffet-coach	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	2 Exide 1 Gould	1,000	....
	77	Coaches	Electro-mech.	B. & O.-York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide, Edison, Gould, K. W., Philco and U. S. L.	1,000	....
B. & M.	20	Coaches	Electro-mech.	General Electric	Motor	Freon	1	20	Gear	Body	Exide	500 at 64 v.	....
	30	Coaches	Ice	Sturtevant	....	Ice	1	4	Flat belt	Body	Edison	256	....
Can. National	50 12 80 26 14 2	Coaches Cafe-chair Sleepers Diners Obs.-sleepers Club-sleepers	Ice	....	....	Ice	1	4 or 5	Flat belt in summer—chain in winter	Truck	Exide, Edison and Gould	600	....
Can. Nat'l. (G. T. W.)	10	Coaches	Ice	....	....	Ice	1	2½ or 3	Flat belt	Body	U. S. L.	350	....
Can. Pacific	67	Sleepers	Ice	....	....	Ice	1	5	Gear	Body	42 Gould; 25 Exide	600	....
	5	Sleepers	Ice	....	....	Ice	1	5	Gear	Body	Edison	595	....
	5	Buffet-lounge	Ice	....	....	Ice	1	5	Gear	Body	Edison	595	....
	4	Sleepers	Ice	....	....	Ice	1	5	Gear	Body	Edison	680	....
	2	Obs.-chair	Ice	....	....	Ice	1	7½	Gear	Body	Gould	600	....
	32	Diners	Ice	....	....	Ice	1	7½	Gear	Body	Edison	595	....
	5	Business	Ice	....	....	Ice	1	7½	Gear	Body	3 Edison 2 Edison	595 1,190	....
	13	Cafe-chair	Ice	....	....	Ice	1	5	Gear	Body	Gould	600	....
	1	Cafe-chair	Ice	....	....	Ice	1	7½	Gear	Body	Gould	600	....
	8	Chair	Ice	....	....	Ice	1	5	Gear	Body	Gould	600	....
	22	Sleepers	Ice	....	....	Ice	1	7½	Gear	Body	Edison	600	....
Cen. of Georgia	30	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	17 Edison; 13 Exide	850	....
	3	Comb.	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	Edison	680	....
	1	Business	Ice	Safety C. H. & L.-A. C. F.	....	Ice	2	4	Flat belt	Body	Edison	1,190	....
Central R. R. of N. J.	1	Cafe	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	U. S. L.	1,000	•
	4	Coaches	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	1 Edison; 3 U. S. L.	1,000	•
C. & O.	20	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	12-3 8-4	Flat belt	Body	Edison, Exide, Gould and U. S. L.	375 to 600	•
(Incl. Pere Marquette)	2	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	500	•
	32	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	8-4 24-3	Flat belt	Body	Lead and alkaline	8-500 24-350	•
	9	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	V belt	Body	Exide	800	....
	2	Business	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V belt	Body	Edison and Exide	1,000	•

* Cars marked thus are equipped for 220-volt a.c. operation at terminals.

Passenger Cars Air-Conditioned During 1937 (Continued)

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators No.	Generators Capacity Kw.	Generators Type of Drive	Generators Type of Mounting	Storage Batteries Make	Storage Batteries Amp.-Hr. Capacity	Outside Power Supply*
C. & E. I.	1	Cafe-coach	Ice	Young Radiator Co.	....	Ice	1	4	Flat belt	Body	K. W.	540	....
	9	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Body	6 Gould; 3 K. W.	900	....
	1	Comb.	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Body	Gould	900	....
C. & N. W.	23	Coaches	Mech.	Waukesha-P. S. C. M. C.	Gas engine	Freon	1	5	V-belt	Body	Exide	600	....
	23	Coaches	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	2[1]	Lounge	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	4	Comb.	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	3	V-belt	Body	Exide	450	....
	2[2]	Coaches	Mech.	Waukesha-Melcher	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	5	Chair	Mech.	Waukesha-Burgess-Trane	Gas engine	Freon	1	4	V-belt	Body	Exide	450	....
	1	Buffet-lounge	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	......	600	*
C. B. & Q.	2	Buffet-coach	Electro-mech.	Frigidaire	Motor	Freon	(Three 50 Kw. Diesel-engine-driven generators on each of two eight-car trains)						*
	3	Buffet-coach	Electro-mech.	Trane Co.	Motor	Freon	1	20	V-belt-gear	Body	Alkaline	1,000	*
	12	Coaches	Electro-mech.	Trane Co.	Motor	Freon	1	20	V-belt-gear	Body	Lead	1,000	*
	6	Coaches	Electro-mech.	Trane Co.	Motor	Freon	1	20	V-belt-gear	Body	Exide	1,000	*
C. M. St. P. & P.	47	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Exide	27–850 20–823	....
	3	Coaches	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Gould	450	....
	2	Sleepers	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Exide	850	....
	7	Sleepers	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Gould	450	....
	5	Comb.	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Exide	823	....
	7	Diners	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Exide	850	....
	4	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Exide	850	....
	2	Lounge	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Exide	850	....
	2	Business	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Exide	850	....
C. R. I. & P.	10	Coaches	Mech.	Waukesha-Trane	Gas engine	Freon	1	4	Flat belt	Body	......	450	....
	3	Lounge	Mech.	Waukesha-Trane	Gas engine	Freon	1	4	Flat belt	Body	......	450	....
D. & H.	1	Cafe-chair	Ice	Safety C. H. & L.	....	Ice	..	..	....	......	Exide	400	....
D. L. & W.	8	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Lead	450	*
	8	Coaches	Electro-mech.	Airtemp	Motor	Freon	1	20	Gear	Body	Edison	1,000	*
	4	Coaches	Electro-mech.	Safety C. H. & L.	Motor	Freon	1	20	Gear	Body	Edison	1,000	*
	1	Buffet-lounge	Ice	Safety C. H. & L.	....	Ice	1	7½	V-belt	Body	Lead	900	....
D. & R. G. W.	7	Coaches	Ice	Young Radiator Co.	....	Ice	1	4	Flat belt	Body	Edison	510	....
	2	Business	Ice	Young Radiator Co.	....	Ice	1	4	Flat belt	Truck	Exide	500	....
Erie	15	Coaches	St. ejec.	Safety C. H. & L.	....	Water	2	4	Flat belt	Body	Edison	675	....
	3	Diners	St. ejec.	Safety C. H. & L.	....	Water	2	4	Flat belt	Body	Edison	750	....
Fla. East Coast	4	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	Edison	600	....
	7	Diners	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	3 Edison 4Exide	750 882	....
Gr. Northern	7	Coaches	Ice	R. R. Co.	....	Ice	1	4	V-belt	6 Truck 1 Body	Exide	500	....
	12	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt	Body	Exide	600	*
	2	Diners	Ice	R. R. Co.	....	Ice	1	5	V-belt	Body	Exide	600	*
	2	Cafe-obs.	Ice	R. R. Co.	....	Ice	1	4	V-belt	Body	Exide	600	....
	1	Business	Ice	R. R. Co.	....	Ice	1	7½	V-belt	Body	Exide	1,000	*
G. M. & N.	4	Coaches	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	3 Exide 1 Edison	200 300	....
	2	Sleeper-coach	Electro-mech.	A. C. F.-York	Motor	Freon	(Driven from main Diesel engine)				......	75 at 110 v.	*
	1	Business	Mech.	Waukesha	Gas engine	Freon	2	5	Flat belt	Body	Edison	1,000	*
Ill. Cent.	1	Coach	Electro-mech.	Airtemp	Motor	Freon	1	20	Gear	Body	Lead	1,000	*
	39	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	V-belt	Body	10 Edison 6 Edison 23 Lead	375 300 405	* * *
Lehigh Valley	1	Club	Electro-mech.	Airtemp	Motor	Freon	1	20	V-belt	Body	Exide	1,000	*

[1]—These cars formerly equipped with ice-activated systems.

[2]—The cars formerly equipped with axle-generator power supply for air conditioning.

2—The cars formerly equipped with axle-generator power supply for air conditioning.

Passenger Cars Air-Conditioned During 1937 (Continued)

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators: No.	Generators: Capacity Kw.	Generators: Type of Drive	Generators: Type of Mounting	Storage Batteries: Make	Storage Batteries: Amp.-Hr. Capacity	Outside Power Supply*
L. & N.	80	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	9 Edison; 37 Exide; 12 Gould; 10 Philco; 12 K. W.; 3 U. S. L	850	....
	3	Diners	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body		850	....
Maine Cent.	5	Coaches	Ice	Sturtevant	....	Ice	1	4	Flat belt	Body	Edison	340	....
M.-K.-T.	5	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	......	1,000	....
	1	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	Exide	1,000	....
	3	Diners	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	Exide	1,000	....
M. St. P. & S. Ste. M.	2	Sleepers	Ice	P. S. C. M. C.	....	Ice	1	3	Flat belt	Body	Gould	600	....
Mo. Pac.	12	Comb.	Ice	R. R. Co.	....	Ice	1	3	Flat belt	Body	Edison	375	....
	15	Comb.	Ice	R. R. Co.	....	Ice	1	4	Flat belt	Body	Edison	375	....
	2	Coaches	Ice	R. R. Co.	....	Ice	2	3	Flat belt	Body	Edison	600	....
	2	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	Edison	750	....
	4	Coaches	Electro-mech.	Airtemp-York	Motor	Freon	1	20	V-belt-gear	Body	Edison	900	•
	4	Chair	Ice	R. R. Co.	....	Ice	2	3	Flat belt	Body	Edison	600	•
	4	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	Edison	750	....
	2	Diners	Ice	R. R. Co.	....	Ice	2	3	Flat belt	Body	Edison	375	....
	2	Diners	Electro-mech.	Airtemp-York	Motor	Freon	1	20	V-belt-gear	Body	Edison	900	•
	1	Cafe-lounge	Electro-mech.	Airtemp-York	Motor	Freon	1	20	V-belt-gear	Body	Edison	900	•
	1	Cafe-chair	Ice	R. R. Co.	....	Ice	2	3	Flat belt	Body	Edison	375	....
	1	Lounge	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	Edison	750	....
	2	Business	Ice	R. R. Co.	....	Ice	2	4	Flat belt	Body	Edison	750	....
N. C. & St. L.	18	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	Edison	852	....
N. Y. C. System	10	Coaches	Electro-mech.	General Electric	Motor	Freon	1	20	Gear	Truck	K. W.		....
	12	Coaches	Electro-mech.	Airtemp	Motor	Freon	1	20	Gear	Truck	K. W.		....
	38	Coaches	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	K. W., Exide	600	....
	15	Coaches	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	K. W., Edison	at 64 v.	....
	28	Diners	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	Gould, Exide		....
	1	Business	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	Exide		•
N. Y. C. & St. L.	8	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	340	•
	2	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	826	•
	4	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	512	•
	1	Business	Mech.	P. S. C. M. C.	Speed reducer	Freon	1 1	4 4	Flat belt V-belt	Body Body	Edison	1,024	•
N. Y. N. H. & H.	50	Coaches	Electro-mech.	Sturtevant-Frigidaire	Motor	Freon	1	20	Gear	Body	Exide	500	•
	5	Grill	Electro-mech.	Sturtevant-Frigidaire	Motor	Freon	1	20	Gear	Body	Exide	500	•
N. & W.	22	Coaches	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	Edison	300 at 110 v.	•
	4	Comb.	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	Edison	300 at 110 v.	•
	1	Instruction	Ice	Trane	....	Ice				(Equipped for 110 v. outside power only)			....
	2	Business	Ice	Trane	....	Ice	1	20	Gear	Body	Exide	300 at 110 v.	....
Nor. Pac.	14	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	9 Exide, 5 Exide	600, 500	•
	2	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Gould	600	•
	3	Lounge-coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Gould	600	•
	10	Cafe-coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Exide	600	•
	1	Diner	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Exide	600	•
Pennsylvania	63	Coaches	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	......	1,000	....
	8	Comb.	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	......	1,000	....
	30	Diners	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	......	1,000	....
	2	Cafe-coaches	Electro-mech.	Frigidaire	Axle and motor	Freon	1	7.6	V-belt	Body	......	1,000	....
Pullman Co.	44	Sleepers	St. ejec.	Safety C. H. & L.	....	Water	2	5	Flat belt	Body	Exide	875	....
	7	Sleeper-obs.	St. ejec.	Safety C. H. & L.	....	Water	2	5	Flat belt	Body	Exide	875	....
	35	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt-gear	Body	Exide	875	•
	41	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	V-belt	Body	Exide	620	•
	9	Cafe-lounge	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V-belt-gear	Body	Exide	875	•
	11	Cafe-obs.-sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V-belt-gear	Body	Exide	875	•
	6	Cafe-lounge-sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	V-belt-gear	Body	Exide	875	•
	2	Sleepers	Electro-mech.	P. S. C. M. C.	Motor	Freon	1 1	15 4	V-belt-gear Flat belt	Body	Exide	1,000	•
	1	Chair	Electro-mech.	P. S. C. M. C.	Motor	Freon	1 1	15 4	V-belt-gear Flat belt	Body	Exide	1,000	•
	348	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	550	•
	10	Sleepers	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt-gear	Body	Exide	550	•
	3	Chair	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	550	•
	2	Chair	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	7½	V-belt-gear	Body	Exide	550	•
	2	Sleepers	St. ejec.	Safety C. H. & L.	....	Water	1	4	Flat belt	Truck	Exide	850	....
	148	Sleepers	Ice	Pullman	....	Ice	1	4	Flat belt	Body	Exide	600	....
	4	Chair	Ice	Pullman	....	Ice	1	4	Flat belt	Body	Exide	600	....
	15	Sleepers	Electro-mech.	P. S. C. M. C.	Motor	Freon	Two streamline trains—two 300-kw., 220-v. three-phase a. c. Diesel-engine-driven generators on each train				1-Exide 710-amp.-hr. 64-v. battery at head end of each train and 1-Exide 175-amp.-hr. battery in observation car of each train		•

Passenger Cars Air-Conditioned During 1937 (Continued)

Railroad	No. of Cars	Type of Cars	Type of System	Manufacturer	Compressor Drive	Refrigerant	Generators No.	Generators Capacity Kw.	Generators Type of Drive	Generators Type of Mounting	Storage Batteries Make	Storage Batteries Amp.-Hr. Capacity	Outside Power Supply*
Reading	6	Coaches	Electro-mech.	General Electric	Motor	Freon	1	20	Gear	Body	Exide	1,000	*
	5	Coaches	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	3 Exide, 2 K. W.	1,000	*
	1	Comb.	Electro-mech.	York	Motor	Freon	1	20	Gear	Body	K. W.	1,000	*
R. F. & P.	4	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	375	*
	3	Diners	Electro-mech.	Frigidaire	Motor	Freon	1	20	Gear	Body	Exide	1,000	*
	1	Business	Ice	R. R. Co.	....	Ice	1	4	Flat belt	Body	Edison	600	....
St. L.-S. F.	3	Comb.	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Exide	450	....
	3	Coaches	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Exide	450	....
	5	Coaches	Ice	R. R. Co.	....	Ice	1	4	Flat belt	Body	2 K. W., 3 U. S. L.	500	....
	3	Coaches	Ice	R. R. Co.	....	Ice	1	4	Flat belt	Body	2 K. W., 1 Exide	500, 450	....
	3	Buffet	Mech.	Waukesha	Gas engine	Freon	1	4	2 Flat belt 1 V-belt	Body Body	2 Exide 1 U. S. L.	450 500	....
	1	Cafe-lounge	Ice	R. R. Co.	....	Ice	1	5	V-belt	Body	Exide	900	....
	3	Chair	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Exide	450	....
	1	Business	Ice	R. R. Co.	....	Ice	1	4	Flat belt	Body	Exide	900	*
S. A. L.	4	Comb.	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	Gear	Body	Edison	300	*
	12	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	300	*
	6	Coaches	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	Gear	Body	Edison	375	*
	5	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	10	Flat belt	Body	Edison	375	*
	1	Business	Electro-mech.	Waukesha-Melcher	Motor	Freon	1	10	Gear	Body	Edison	900 at 110 v.	*
Southern	2	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	Flat belt	Body	Exide	600	*
Sou. Pac.	49	Coaches	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Edison	900	....
	4	Chair	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Edison	900	....
	4	Cafe	St. ejec.	Safety C. H. & L.	....	Water	1	15	V-belt	Body	Edison	1,200	....
	2	Chair-obs.	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Edison	900	....
	2	Comb.	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Edison	300	....
	2	Diners	St. ejec.	Safety C. H. & L.	....	Water	1	15	V-belt	Body	Edison	1,200	....
	2	Buffet	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt	Truck	Edison	1,200	....
	2	Diner-lounge	St. ejec.	Safety C. H. & L.	....	Water	1	15	V-belt	Body	Edison	1,200	....
	22	Lounge	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Edison	600	....
	21	Diners	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Edison	450	....
	21	Coaches	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Edison	375 or 600	....
	6	Business	Mech.	Waukesha	Gas engine	Freon	1	7½	V-belt	Truck	Edison	750	....
	2	Cafe-lounge	Mech.	Waukesha	Gas engine	Freon	1	4	Flat belt	Body	Edison	600	....
	2	Assembly	Mech.	Waukesha	Gas engine	Freon	1	5	V-belt	Truck	Edison	600	....
Tex. & Pac.	1	Lounge	St. ejec.	Safety C. H. & L.	....	Water	1	10	V-belt-gear	Body	Edison	900	....
	2	Diner-obs.	Mech.	Waukesha-Sturtevant	Gas engine	Freon	1	10	V-belt-gear	Body	Edison	900	....
	1	Diner	Mech.	Waukesha-Sturtevant	Gas engine	Freon	1	10	V-belt-gear	Body	Edison	900	....
Union Pac.	40	Chair	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	*
	17	Chair	St. ejec.	Safety C. H. & L,	....	Water	2	5	Flat belt	Body	Exide	1,000	....
	5	Cafe-lounge	Electro-mech.	Airtemp	Motor	Freon	1	20	V-belt-gear	Body	Exide	1,000	*
	4	Diners	Electro-mech.	Airtemp	Motor	Freon	1	20	V-belt-gear	Body	Exide	1,000	*
	8	Diners	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	*
	5	Sleeper-chair	Mech.	Waukesha	Gas engine	Freon	1	5	Flat belt	Body	Exide	500	....
	5	Kitchen	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	*
	3	Lounge	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	Exide	500	*
	9	Lounge	St. ejec.	Safety C. H. & L.	....	Water	2	5	Flat belt	Body	Exide	1,000	....
	1	Business	Mech.	Waukesha	Gas engine	Freon	1	10	V-belt	Truck	Exide	1,000	....
Wabash	18	Coaches	Ice	R. R. Co.	....	Ice	1	3	Flat belt	Body	Edison, Exide, K. W. and Philco	350 and 500	....
	2	Business	Ice	R. R. Co.	....	Ice	1	4	Flat belt	Body	Edison	1,000	....

Summary of Cars Air Conditioned During 1937

	Number of Cars	Type of Car: Coach	Combi-nation	Dining (Note A)	Chair (Note B)	Observa-tion	Sleeping (Note C)	Business	Type of System: Electro-Mech.	Direct Mech.	Ice	Steam Ejector	Refrigerant Used: Freon	Water	Ice
Alton	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
A. T. & S. F.	75	...	6	16	48	...	5	...	...	...	...	75	...	75	...
A. C. L.	34	16	...	18	...	...	...	...	8	...	...	26	8	26	...
B. & O.	97	77	11	5	4	...	...	...	97	...	...	...	97	...	...
B. & M.	50	50	...	...	...	...	...	...	20	...	30	...	20	...	30
Can. National	194	60	...	38	...	...	96	...	...	...	194	...	...	...	194
Can. Pacific	164	...	...	51	8	2	98	5	...	...	164	...	...	...	164
Cen. of Ga.	34	30	3	...	...	...	...	1	...	...	1	33	...	33	1
C. R. R. of N. J.	5	4	...	1	...	...	...	...	5	...	...	...	5	...	...
C. & O.	65	61	...	2	...	...	...	2	...	56	...	9	56	9	...
C. & E. I.	11	9	1	1	...	...	...	...	...	...	1	10	...	10	1
C. & N. W.	56	46	4	1	5	...	...	...	...	56	...	...	56	...	...
C. B. & Q.	23	18	...	5	...	...	...	...	23	...	...	...	23	...	...
C. M., St. P. & P.	79	50	5	7	6	...	9	2	...	12	...	67	12	67	...
C. R. I. & P.	13	10	...	...	3	...	...	...	...	13	...	...	13	...	...
D. & H.	1	...	...	1	...	...	...	...	...	...	1	...	...	...	1
D. L. & W.	21	20	...	1	...	...	...	...	12	8	1	...	20	...	1
D. & R. G. W.	9	7	...	...	...	...	...	2	...	...	9	...	...	...	9
Erie	18	15	...	3	...	...	...	...	...	...	...	18	...	18	...
Fla. E. C.	11	4	...	7	...	...	...	...	...	...	...	11	...	11	...
Gr. Nor.	24	19	...	4	...	...	...	1	...	12	12	...	12	...	12
G. M. & N.	7	4	...	...	...	...	2	1	2	5	...	...	7	...	...
Ill. Cent.	40	40	...	...	...	...	...	...	1	39	...	...	40	...	...
Leh. Val.	1	...	...	...	1	...	...	...	1	...	...	...	1	...	...
L. & N.	83	80	...	3	...	...	...	...	...	...	...	83	...	83	...
Me. Cen.	5	5	...	...	...	...	...	...	...	...	5	...	...	...	5
M.-K.-T.	9	...	...	3	6	...	...	...	...	...	...	9	...	9	...
M., St. P. & S. Ste. M.	2	...	...	...	...	...	2	...	...	...	2	...	...	...	2
Mo. Pac.	42	8	17	6	9	...	...	2	7	...	28	7	7	7	28
N. C. & St. L.	18	18	...	...	...	...	...	...	...	...	...	18	...	18	...
N. Y. C. System	104	75	...	28	...	...	...	1	104	...	...	...	104	...	...
N. Y. C. & St. L.	15	10	...	4	...	...	...	1	...	15	...	...	15	...	...
N. Y., N. H & H.	55	50	...	5	...	...	...	...	55	...	...	...	55	...	...
N. & W.	29	22	4	...	...	...	...	3	26	...	3	...	26	...	3
Nor. Pac.	30	19	...	11	...	...	...	...	...	30	...	...	30	...	...
Penna.	103	63	8	32	...	...	...	...	103	...	...	...	103	...	...
Pullman Co.	688	...	...	9	10	...	669	...	18	617	...	53	635	53	...
Reading	12	11	1	...	...	...	...	...	12	...	...	...	12	...	...
R. F. & P.	8	4	...	3	...	...	...	1	3	4	1	...	7	...	1
St. L.-S. F.	22	11	3	4	3	...	...	1	...	12	10	...	12	...	10
S. A. L.	28	18	4	5	...	...	...	1	1	27	...	...	28	...	...
Southern	2	2	...	...	...	...	...	...	...	...	...	2	...	2	...
Sou. Pac.	141	70	2	33	28	...	...	8	...	74	...	67	74	67	...
T. & P.	4	...	...	3	1	...	...	...	...	3	...	1	3	1	...
Un. Pac.	97	...	...	22	69	...	5	1	9	62	...	26	71	26	...
Wabash	20	18	...	...	...	...	...	2	...	...	20	...	...	...	20
Western Pac.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	2,549	1,024	69	332	201	2	886	35	507	1,045	482	515	1,552	515	482

Note A—Includes lounge-diners, coach-diners, cafe-chair, cafe-coach, kitchen-coach and buffet cars.
Note B—Includes lounge-chair, coach-chair and observation-chair cars.
Note C—Includes lounge- and observation-sleepers.

Eight-Year Summary of Air-Conditioned Cars

	Total Cars		Type of Car							Type of System				Type of Refrigerant			
	Dec. 31, 1936	Dec. 31, 1937	Coaches	Comb.	Dining (Note 1)	Chair (Note 2)	Observ.	Sleeping (Note 3)	Business	Electro-Mech.	Direct Mech.	Ice	Steam Ejector	Freon	Water	Ice	Other Refrigerants
Alton	25	25	4	4	9	6	2	...	...	25	...	...	...	24	...	...	1
A. T. & S. F.	187	262	26	6	65	142	18	5	...	1	...	...	261	...	261	...	1
A. C. L.	75	109	81	...	28	...	...	...	...	11	...	...	98	11	98	...	...
B. & O.	275	372	240	55	59	8	8	...	2	372	...	...	...	372	...	...	...
B. & M.	43	93	85	4	4	...	...	...	...	33	...	60	...	33	...	60	...
Can. National	56	250	60	...	41	27	...	122	...	...	...	250	...	...	...	250	...
Can. Pacific	141	305	8	4	56	14	6	212	5	2	7	295	1	9	1	295	...
Cen. of Ga.	13	47	41	3	2	...	...	...	1	...	...	1	46	...	46	1	...
C. R. R. of N. J.	18	23	17	2	4	...	...	...	...	23	...	...	...	23	...	...	...
C. & O. (Incl. Pere Marquette)	52	117	92	4	14	...	...	...	7	...	108	...	9	108	9	...	...
C. & E. I.	20	31	20	3	8	...	...	...	...	...	...	6	25	...	25	6	...
C. & N. W.	150	206	121	14	41	20	10	...	...	14	104	88	...	104	...	88	14
C. B. & Q.	133	156	61	...	43	39	5	8	...	118	4	34	...	122	...	34	...
C. M., St. P. & P.	163	242	105	5	35	29	4	62	2	...	14	...	228	14	228	...	...
C. R. I. & P.	119	132	59	4	31	34	4	...	...	...	15	105	12	15	12	105	...
D. & H.	5	6	...	...	6	...	...	...	...	...	...	6	...	...	...	6	...
D. L. & W.	33	54	40	...	12	...	1	...	1	17	23	14	...	40	...	14	...
D. & R. G. W.	40	49	28	...	12	...	7	...	2	...	...	49	...	...	...	49	...
Erie	22	40	30	...	7	...	...	...	3	1	...	...	39	1	39	...	...
Fla. E. C.	32	43	30	...	13	...	...	...	...	...	...	...	43	...	43	...	...
Gr. Nor.	37	61	35	...	24	...	...	...	2	...	12	49	...	12	...	49	...
G. M. & N.	5	12	5	...	2	...	...	4	1	7	5	...	...	12	...	...	...
Ill. Cent.	120	160	99	10	35	10	2	...	4	12	135	13	...	147	...	13	...
Leh. Val.	14	15	4	...	7	4	...	...	...	15	...	...	...	15	...	...	...
L. & N.	52	135	119	...	16	...	...	...	...	...	...	...	135	...	135	...	...
Me. Cen.	12	17	15	2	...	...	...	...	...	...	...	17	...	...	...	17	...
M.-K.-T.	17	26	...	...	12	9	4	...	1	6	...	3	17	3	17	3	3
M., St. P. & S. Ste. M.	7	9	...	...	3	...	4	2	...	...	7	2	...	7	...	2	...
Mo. Pac.	303	345	132	33	102	62	5	...	11	43	1	239	62	43	62	239	1
N. C. & St. L.	13	31	25	...	6	...	...	...	...	...	...	...	31	...	31	...	...
N. Y. C. System	208	312	181	1	126	2	1	...	1	239	58	15	...	297	...	15	...
N. Y. C. & St. L.	6	21	15	...	4	...	...	...	2	...	21	...	...	21	...	...	...
N. Y., N. H. & H.	332	387	329	17	35	2	4	...	...	254	...	133	...	254	...	133	...
N. & W.	91	120	84	19	11	...	...	...	6	110	...	6	4	110	4	6	...
Nor. Pac.	53	83	39	...	28	2	14	...	...	...	83	...	...	83	...	...	...
Penna.	502	605	351	103	151	...	...	...	...	185	...	419	1	184	1	419	1
Pullman Co.	4,151	4,839	...	...	9	391	494	3,945	...	187	2,920	1,352	380	3,107	380	1,352	...
Reading	46	58	39	11	8	...	...	...	...	58	...	...	...	58	...	...	...
R. F. & P.	17	25	14	2	8	...	...	...	1	13	9	1	2	22	2	1	...
St. L.-S. F.	85	107	50	5	25	17	5	2	3	...	13	94	...	13	...	94	...
S. A. L.	67	95	47	17	27	...	...	...	4	4	91	...	...	95	...	...	...
Southern	34	36	2	...	34	...	...	...	...	...	...	...	36	...	36	...	...
Sou. Pac.	259	400	169	2	103	114	4	...	8	...	100	225	75	100	75	225	...
T. & P.	57	61	39	...	12	5	3	...	2	1	9	21	30	10	30	21	...
Un. Pac.	221	318	63	...	83	129	37	5	1	26	228	...	64	254	64	...	...
Wabash	46	66	41	...	18	4	...	...	3	...	...	66	...	...	...	66	...
Western Pac.	15	15	7	...	5	...	3	...	...	...	3	...	12	3	12	...	...
Total	8,372	10,921	3,052	330	1,384	1,070	645	4,367	73	1,777	3,970[4]	3,563	1,611	5,726	1,611	3,563	21

Note 1—Includes lounge-diners, coach-diners, cafe-chair, cafe-coach, kitchen-coach and buffet cars.
Note 2—Includes lounge-chair, coach-chair and observation-chair cars.
Note 3—Includes lounge- and observation-sleepers.
Note 4—Includes 250 cars on which the compressor is driven by a gas engine.

EDITORIALS

The Height Of Luxury

The Victorian Railways (Australia) recently completed a streamlined, air-conditioned, steam-locomotive-propelled train, "The Spirit of Progress," in their workshops at Newport, which will make a non-stop run of about 190 miles between Melbourne, over the border of New South Wales to Albury. It will accommodate more than 400 passengers and seems to be comparable with the streamlined trains operating in this country; it will make an average speed of about 50 miles an hour, touching 70 miles an hour on those sections of the track on which such speeds are permissible.

Apparently it is luxurious not only for the traveler, but for the trainmen as well. The Argus, a Melbourne newspaper, under the caption of "The Guard Will Have a Periscope," publishes this item: "How many small boys have reveled in the opportunity of sitting in the high perch of an ordinary guard's van, from which the guard watches the signals ahead! For the guard, the novelty of the position soon wears off and many will envy the guard of the new train. He sits in his chair in the proper place for a chair to be —on the floor. High above him a window provides a view along the whole of the top of the train to the signals ahead, and he watches the scene reflected in a mirror set comfortably in front of him. A second sloping mirror, in front of the upper window, completes the guard's periscope."

In this country the engineer and fireman have the sole responsibility for watching for the signals ahead; their task is simplified on some roads, and particularly in bad weather, by the use of cab signals. The brakeman on the rear end of the high-speed trains is unusually concerned with keeping track of what goes on behind or alongside the train. On one road, all employees along the right-of-way are ordered to watch the high-speed trains critically as they pass and to indicate to the brakeman by proper acknowledgment if all is right, or if something is at fault. This brakeman sits in a chair—on the floor—but his duties are more exacting—and possibly more productive—than those of the periscope attendant.

The Victorian Railways officers and employees are proud of the fact that the interior paneling of the cars in the new train is made from the most beautiful of Australian timbers, the sheets for each compartment being carefully graded. It is said that not one of the thousands of these panels, which were trimmed, fitted and polished at the company workshops, was damaged in any way.

Another item of interest to American railroaders is the fact that the baggage racks have rubber-covered front bars, to prevent the baggage from slipping.

The rapidly extending use and development of high-speed passenger trains throughout the world promises to bring about more and more improvements and conveniences, which will lure business away from competing types of carriers and back to the rails. Incidentally the railroads of the United States are not alone in suffering from such competition.

Useless Waste

The author of the paragraph captioned "Importance of Using Standard Specifications" on the Gleanings page of this issue, could have placed even stronger emphasis on the advisability of using standard specifications. It, of course, does not cost the railroad company directly very much to print its own individual sets of specifications, but their use places a heavy expense on the railway supply companies, and this of necessity will be reflected back in the higher prices which they must ask for their products.

It would be difficult to estimate accurately this added cost, but the engineering departments of those companies which manufacture basic materials and supplies can give concrete evidence of the great amount of extra work to which they are put, where the different railway companies insist on their own individual specifications, differing only in certain details from standard specifications which have been adopted and approved of by the Association of American Railroads, or the American Society for Testing Materials. Company specifications must be checked with great care against the standard specifications, and obviously higher prices must be asked for those materials which deviate far enough from the standard specifications to necessitate special effort and handling to conform to them. Even though this may not be necessary, the cost of checking the specifications in the engineering department and the details involved in dealing with the sales and production departments, makes for a very considerable added expense in many instances.

While there may be occasions when such deviations are advisable, there is no question but that some railroads can make large savings, directly and indirectly, by conforming to the standard specifications and designating them in asking for prices. This is one form of waste which should not be condoned.

Locomotive Smoke Elimination

The December, 1937, report of locomotive smoke performance of Hudson County, N. J., shows the very low average smoke density of 0.68. This is the result of 875 locomotive stack observations on the nine railroads which operate in that county. Four of the roads, the New York Central, the Lehigh Valley, the Reading and the New York, Ontario & Western, had a perfect record—0.00. This is the result of a number of years of continued and persistent effort on the part of the Department of Smoke Regulation of Hudson County, and with the hearty co-operation of the Railroad Smoke Association and the railway organizations supporting it.

No approach to the problem has been left uncovered. As an illustration, the December meeting of the association was featured by an address on Locomotive Maintenance in Relation to Smoke, by Superintendent Motive Power and Rolling Stock, A. K. Galloway, of the Jersey Central and Reading. James Partington of the American Locomotive Company, addressed the January meeting on Improvements in Design Tending to Better Smoke Performance in Locomotives. In like manner, almost every phase of railroad operation which is in any way concerned with the efficient combustion of fuel and smoke prevention has been painstakingly studied and discussed during recent years.

The Smoke Association meets monthly, the sessions lasting for two hours from 2:00 p. m. to 4:00 p. m. This allows ample time for discussion after the address. As a result, there has been a steady decrease in the volume of locomotive smoke during the several years that the movement has been under way. The attitude of the railroads and the results which have been secured through their co-operation, have not only been appreciated by the public, but have stimulated other groups to make similar efforts. A Marine Association, for instance, has been functioning almost as long as the Railroad Association, and more recently a strong association has been organized by the industries in Hudson County. The railroads are to be congratulated for the lead that they have taken in this movement.

Fuel Costs Are Up

As a result of new wage agreements and the National Bituminous Coal Act designed to regulate prices and trade practices, railroads are unquestionably faced with a substantial advance in the cost of coal, especially that used in locomotive service. In fact, it is estimated that new prices already in effect will increase railroad coal costs by more than $19,000,000 during the present year. This means that railroad mechanical officers have the definite responsibility of redoubling their efforts in the interest of fuel economy, which means keeping motive power in the best operating condition practicable and rechecking all of the hundred and one details of locomotive construction and operating practice which have a bearing on fuel performance.

An example of the present trend towards increased fuel costs is afforded by figures issued by the I. C. C., Bureau of Statistics, the latest figures available being for November, 1937, as compared to November, 1936. During this 12-month period pounds of coal per 1,000 gross ton-miles decreased from 123 to 122, or 0.81 per cent, and pounds of coal per passenger train car-mile decreased from 15.7 to 15.5, or 1.27 per cent. During the same period the cost of fuel per 1,000 gross ton-miles increased from 15.85 to 16.85 cents or 6.30 per cent, and the cost of fuel per passenger train car mile increased from 2.02 to 2.14 cents, or 5.94 per cent. The average cost of fuel per equated ton mile (coal equivalent) increased from $2.58 in November, 1936, to $2.76 in November, 1937, or 6.98 per cent.

In other words, in spite of a slightly more efficient use of fuel in November, 1937, the cost per unit of work done increased about 6 per cent on the average due to increased cost of coal at the mines. The Railway Fuel & Traveling Engineers' Association is taking steps to bring these facts to the attention of railroad men generally, a worthy effort which this publication is glad to support and supplement wherever possible.

The increased costs of railway fuel on a ton basis for coal and a barrel basis for oil are largely out of the control of railroad men. Much can be done, however, to reduce the total amount of the fuel bill by avoiding the unfortunate cumulative effect of inefficient practices combined with high-purchase price. It is particularly important, for example, to re-check fuel saving devices, not previously installed because of apparent high first cost, but which now are amply justified by the savings possible when high-priced fuel is used.

The effective fuel conservation efforts of railroad mechanical department officers working on their own individual roads and through an aggressive specialized group like the Railway Fuel & Traveling Engineers' Association were never more needed nor potentially productive in saving railroad fuel money, than today.

The Correct Cutting Fluid

In a machine shop one often sees all drilling, cutting, milling and grinding operations being performed with the same cutting fluid. This raises the question: How much consideration are men responsible for the recommendation and purchase of cutting fluids giving to the length of tool life in machining operations as effected by cutting fluids?

Information is available from various sources showing that the proper cutting fluid can be ascertained

only through extensive tests of the various machining operations. For example, it has been determined, when machining S. A. E. 3140 steel with 18-4-1 high-speed tools and using a feed of 0.0125 in. and a cut of 0.1 in. deep, that a tool life of two hours can be maintained (1) at a cutting speed of 83 ft. per min. when cutting dry; (2) at a cutting speed of 89 ft. per min. with plain mineral oil; (3) at 93 ft. per min. with emulsion of one part oil and 16 parts water; (4) at 97 ft. per min. with a sulpherized mineral oil; (5) at 100 ft. per min. with 0.153 per cent by weight of colloidal graphite added to the 1-16 emulsion; and (6) at 106 ft. per min. when cutting with 0.153 per cent by weight of colloidal graphite added to mineral oil. At a uniform cutting speed the five cutting fluids mentioned would give a progressively increasing tool life.

To give another example, it has been found that the life of a tungsten-steel blade in a motor-driven saw will vary with the cutting fluid used. Practically all cutting fluids show an increase in cutting time per piece as production increases, but the rate of increase of cutting time varies with the type of cutting fluid used. Usually, a sulpherized lard oil blended with small parts of mineral oil will show the greatest economy in regard to the life of the saw blade when cutting ferrous materials, although the cutting time per piece, when the blade is new, may be slightly lower than when other cutting fluids are used.

Many shops can well afford to investigate the results of tests offered by those who produce such cutting fluids and by individual disinterested investigators in this field. Although the two examples given herein in no way attempt to summarize the extended research in this field, they do suggest that real economy in machining operations can be effected by the selection of the cutting fluid which will produce either the best quality or the greatest production, or both. Some of the cutting fluids mentioned herein may not be the cheapest available, but because they have peculiar characteristics which certainly affect tool life advantageously they cannot be selected on a price basis alone. Accurate tests of machining operations with various cutting fluids is the one best means to that end.

New Books

THE RAILWAY CARRIAGE & WAGON HANDBOOK. *Published by The Locomotive Publishing Co., Ltd., 3 Amen Corner, London, E. C. 4. 366 pages, 5 in. by 7 in., cloth bound. Price, $1.*

General principles underlying British practice, rather than individual practices, are dealt with in this handbook. Both wood-framed and all-steel passenger-car bodies—floors, roofs, ceilings, interior finish, timber, etc.—are discussed in Chapter 1. Separate chapters are devoted also to painting; the passenger-car underframe; trucks; freight-car design; buffers and draft gear; wheels; mass production of freight cars; progressive repairs; inspection; lightweight in coach construction; interior metal work and its decorative treatment, and railway gages. British standard specifications for materials are then presented.

TRAVELING ENGINEERS EXAMINATION BOOK. *Prepared and published by the Railway Fuel and Traveling Engineers' Association, Old Colony building, Chicago. 256 pages. Bound in cloth. Price of individual copies $1.50, with suitable percentage reductions for quantity orders.*

This 1937 revision of the book formerly issued by the Traveling Engineers' Association has been brought up to date and now contains more than 1,200 questions and answers relating to the locomotive and its operation, as well as such accessories as stokers, boosters, reverse gears, superheaters, mechanical lubrication, feedwater heaters and the latest type of air brakes.

SMOKE AND BOILER ORDINANCES. *Manual compiled and published for the Smoke Prevention Association, Secretary Frank A. Chambers, Room 1001 City Hall, Chicago. 152 pages, 6 in. by 9 in. Price: Paper bound 50 cents.*

This manual of smoke and boiler ordinances and requirements is published in the interest of smoke and air pollution regulation and increased efficiency in fuel combustion. It is the official publication of the Smoke Prevention Association and includes, in addition to recommended methods for measuring air pollution, a synopsis of papers read before the thirty-first annual convention held at New York, June 1 to 4, 1937. Of particular interest to railroad men are the papers on "Locomotive Smoke Abatement", by E. E. Ramey, fuel supervisor, Baltimore & Ohio; and "What the Railroads Have Done to Abate Smoke in Hudson County, N. J.", by George H. Massey, Hudson County, N. J.

SMOLEY'S SEGMENTAL FUNCTIONS — TEXT AND TABLES. *Published by C. K. Smoley and Sons, Scranton, Pa. 186 pages, 4½ in. by 7 in. Leather bound. Price, $5.*

Simple methods of solving a circular segment and of computing its area, when the segment is given with any two of its five parts—viz., the arc, the chord, the radius, the central angle and the height—with numerous examples illustrating the application of these methods are contained in this book by C. K. Smoley. Since the publication of his book "Parallel Tables of Logarithms and Squares of Feet, Inches and Fractions of an Inch" in 1901 the author has continually received requests from engineers and architects for a book which could be used in combination with that book in solving problems dealing with parts of a circular segment. With that aim in view he conceived the idea of accomplishing for the solution of the circular segment what the trigonometric functions had done for the solution of the triangle; hence, the introduction of segmental functions in the present book.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Ways of Wasting Locomotive Fuel

Fuel conservation is a matter of continual discussion on all railroads. As a rule the subject is approached from the standpoint of saving fuel. Why not stress wasting fuel? Here is a question I should like to propound. How many ways can you enumerate of wasting fuel on a locomotive? I have in mind an up-to-date design, equipped with stoker, booster, feedwater heater, etc.

Importance of Using Standard Specifications

Material specifications have for years been individual on a large number of roads. For all basic materials, rails, tires, axles, plates, etc., all essentials are identical. A single A. A. R. or A. S. T. M. specification would secure the same quality of material. The practice of each railroad printing and issuing its own specification seems unnecessary. The expense involved in frequent reissues and in distribution to all interested departments as well as to the concerns which may bid on this material, has seemed to be a practice which has really outgrown its usefulness. It is easily understood that mechanical and test departments like to have a specific document bearing the railway company's heading. This practice was fully justified when it originated at a time when there was no American Society of Testing Materials, nor was there a unified railway organization which concerned itself energetically in the preparation of specifications and in their regular revision as the state of the art developed. In the writer's opinion the abandonment of specific railroad specifications, and an earnest desire to use A. S. T. M. or A. A. R. specifications for generally used material, offers the possibility of considerable saving.

Goals to Shoot At

At one time a number of years ago—back in the early 20's, I think it was—it was the practice on many railroads to establish goals or objectives toward which to strive, in the effort to improve the efficiency and effectiveness of a department or of operations as a whole. One division would compete with another, or one shop or department with another, thus stimulating a keen interest in better performance throughout the departments, or through the entire railway organization. Unless I am mistaken, there is not much of this being done at the present time. Obviously it must have paid, and paid well, in promoting economies and increasing efficiency of operation. Why don't you advocate starting something of this sort today? Incidentally, I can recall the time when in the effort to promote shop efficiency, your own magazine staged frequent competitions for the best shop kinks or the best methods of performing certain operations. Has the depression hit us so hard that our spirit and our sportsmanship have been lowered or reduced to a point where we have become insensible to such appeals? Except for safety competitions, which have become more or less routine, can you name other types of competitions in the mechanical departments of our railroads?

Departmental Safety Meetings

How many railroads have monthly departmental meetings with the men and the foremen? Many manufacturing concerns follow such practice. It gives the foremen an opportunity to cultivate friendly relations with the employees and permits misunderstandings as to rules and regulations to be cleared up. Production problems are also discussed, but safety should be the main topic of discussion. The supervisor in charge of such meetings should take special pains to see that they are not only instructional, but are so interesting that the men will want to attend them.

Eyes That Do Not See

It ought not to be necessary to have an outsider come in and tell us how to do our job better, and yet, what a jar we sometimes get when such a person questions about why we do a certain thing in a certain way. We have an operation in our shop of which we felt we could be justly proud, because of the improvement which we have made as compared to former practices. The other day we were showing it to a visitor to whom the entire operation was new and unfamiliar. Imagine our dismay when he asked a simple question that almost automatically suggested a still further improvement which could be readily made to excellent advantage. Since that time I have been trying to look at and study familiar, routine jobs with a more questioning mind and critical attitude. Just why do we do a certain job in a certain way? Is there not some way of doing it more easily and inexpensively? Have conditions changed since the method or practice was first inaugurated, which might well warrant making an entire restudy of the operation or the method of handling?

Trains Still Fascinate Public

Enjoying a monopoly of the transportation field for so many years, the railroads formerly had little or no incentive to cultivate public interest and good-will, and some of them made but a feeble effort to cultivate either. There is, therefore, good reason for amazement at the sustained interest which the general public unquestionably exhibits toward all things connected with the operation of railroads. My working hours are spent at a large industrial plant, so situated that it affords a clear view of every form of transportation—steam trains, motor vehicles, military and commercial airplanes, and, until recently, multiple unit electric cars. Though not unusual so far as my observation goes, the difference in the reaction of the workingmen to the passage of these various transport units is worthy of notice. Large buses or motor trucks rarely draw a glance; airplanes, if in deafening formations of a half dozen or more, may evoke some slight interest; but, when a fast passenger train rushes by, or a heavy freight passes with its interminable string of cars, nearly every eye is riveted on the engine for a moment. The numbers and characteristics of the engines usually seen on the various trains are well known, and the appearance of a strange engine is immediately recognized and commented upon by the men. With one exception, all these engines are of the most ordinary varieties, without any streamlining, dashes of color, or other up-to-date frills which might create unusual interest. The one exception is a 600-hp. Diesel-electric switcher, which began work very quietly a short time ago and has since caused much discussion and speculation among railroad men and others. Some of the misinformation concerning this engine, now being circulated by those who ought to know better, would gain little credence if the owners had given proper publicity to its advent.

With the Car Foremen and Inspectors

Illustrations of Journal-Bearing Troubles

Notwithstanding the importance attached to the use of proper lubricants in journal boxes of railroad equipment, it is a well-known fact that the solution of the hot-box problem lies not alone in the quality of the oil and waste. In packing the box, railroad officers who are familiar with this phase of train operation will at once agree that it is equally important to see that all the mechanical parts of the journal box are in proper order; for example, the journal and bearing, the bearing wedge, the box, the box lid and dust guard must be in good repair to insure satisfactory lubricating performance.

Frequently, the cause of a hot box is ascribed to the inferior quality of the lubricant, when upon investigation it will be found that some mechanical defect present in the journal-box assembly contributed to the failure and very likely was the primary cause of all the trouble. Often, too, the evidence is destroyed, in which case the actual cause cannot be determined. The purpose of this article is to bring to the reader's attention two major causes contributing to the hot-box problem; namely, the journal bearing and the journal-bearing wedge, and to show by illustrations some of the actual conditions recently found on cars of various ownerships while on repair tracks undergoing repairs.

Unquestionably a marked improvement has been made in the hot-box situation since the introduction of rule 66 of the A. A. R. Interchange Code. This rule sets forth a course of procedure which should be followed if the objectives sought are to be attained. It will be apparent from the accompanying illustrations that a further improvement can be effected if greater care be given to the mechanical details when cars receive periodic repacking of journal boxes. To that end we

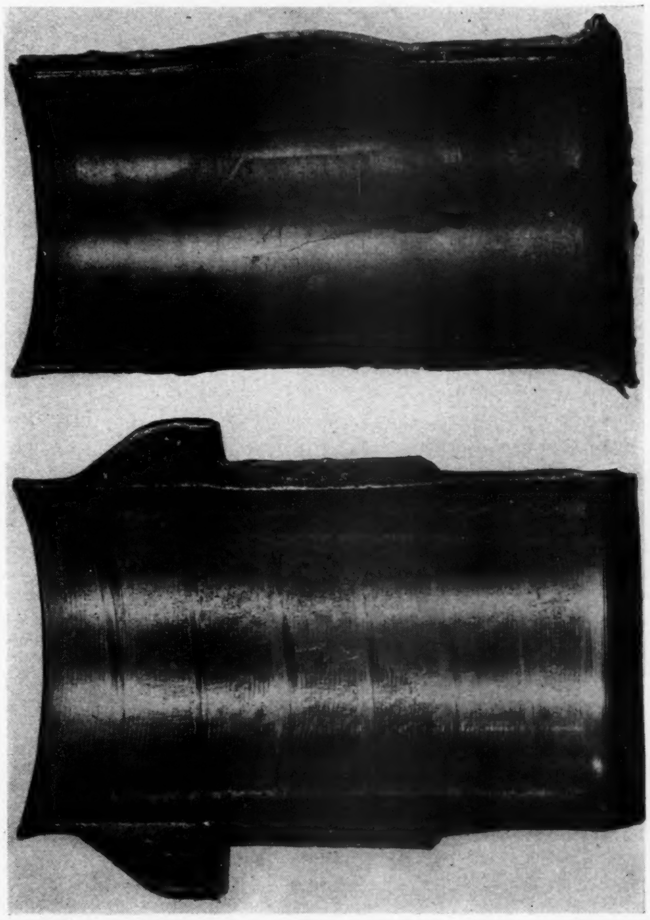


Fig. 2—The bearing metal shown at the top became loose after this second-hand bearing, unsuited to the journal diameter, had been applied

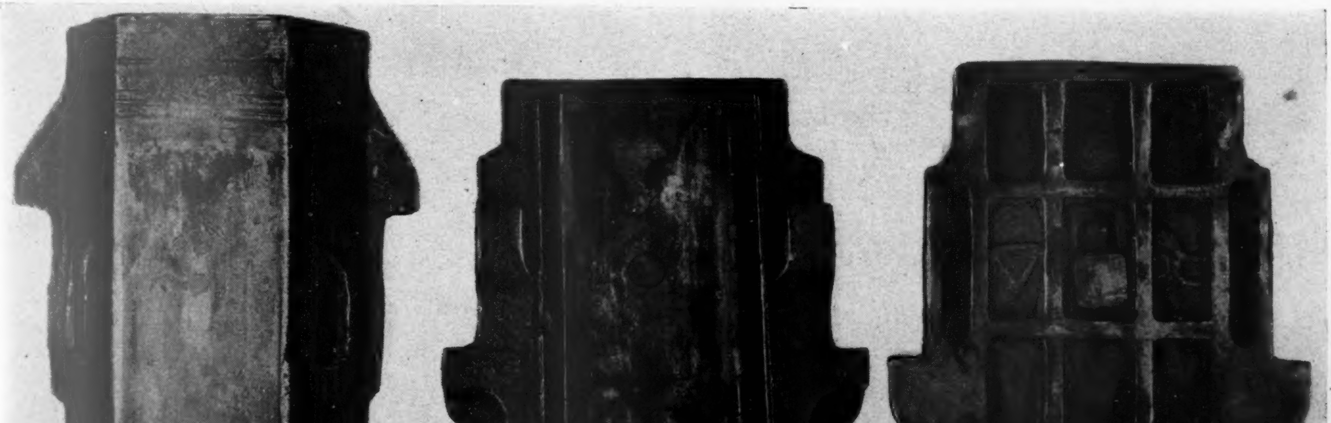


Fig. 1—An antiquated wedge that should have been discontinued in service

Fig. 3—A faulty journal fillet caused this bearing condition

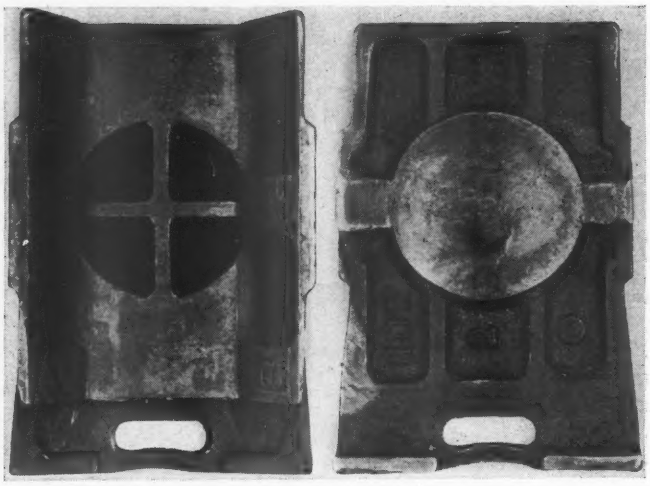


Fig. 6—Wedge of obsolete design removed recently from a car—Note the uneven bearing surface where the wedge contacted the box

must look to our supervision to see that rule requirements are complied with.

While this subject is not new, it is hoped that the material presented here will prove interesting and informative. Train delays are expensive and sometimes embarrassing. Such delays arising from hot boxes can be avoided, to a great extent, by proper workmanship and by using lubricants of proper quality.

Fig. 1—Do you recall this type of wedge? Some of the "old timers" will. Admittedly this wedge has seen years of service and has long since outlived its usefulness. Note the condition of the journal bearing, particularly where the sliding section wore into the back. One can see at a glance what caused the wear on the lugs at the inside of the wedge and the consequent pinching of the bearing and retarding of the oil flow. These were removed from a car that bore a repack stencil of recent date.

Fig. 2—This bearing was removed in a transportation yard where a wide-awake inspector had noted that the babbitt lining had slipped below the bearing shell. Apparently someone had applied a second-hand bearing unsuited to the diameter of the journal. During wheel changes it is important, when second-hand bearings are used, to caliper the journal to determine whether the bearing is of proper size. In the case of repacks it is more economical to apply a new bearing when in doubt rather than to risk the application of a poor second-hand bearing. Note the bearing surface on the side of the shell and you will readily understand how this undersized fit affected the bearing, causing the shell to fracture at the side and the lining to crack and become loose.

Fig. 3—Except for the worn condition of the fillet end, this bearing otherwise looks like a new one. The excessive wear indicated, causes one to wonder what consideration axle fillets are receiving when axles go through the shops for attention. Perhaps it would be advisable to investigate our wheel and axle practices to ascertain whether the fillets are being properly machined.

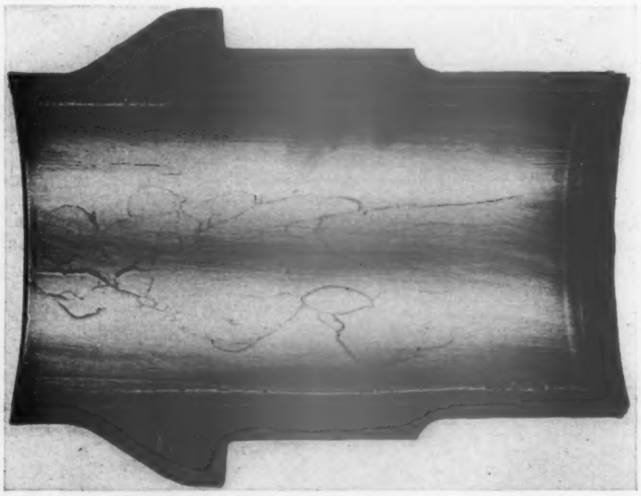


Fig. 4—Progressive cracking caused by hydraulic pressure between the lining and the shell when once a small crack appears

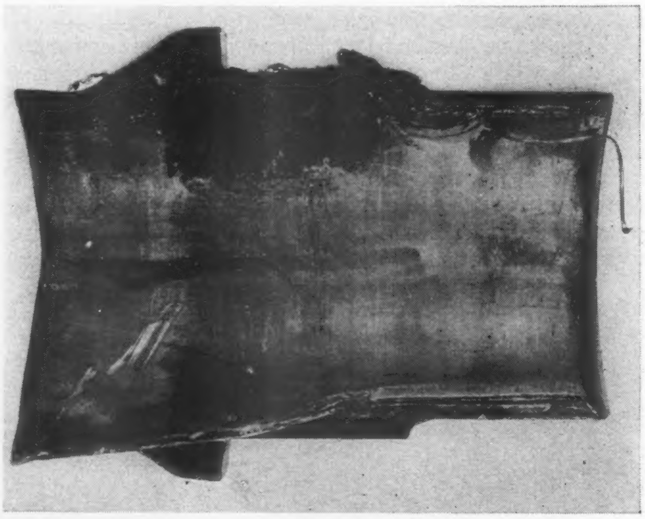


Fig. 7—The car inspector's friend—a waste grab

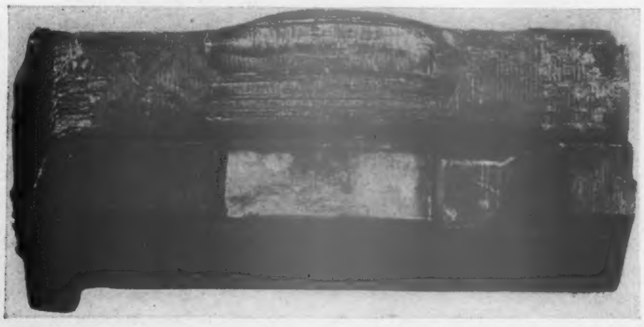


Fig. 5—A simple hammer test might have discovered this loose lining

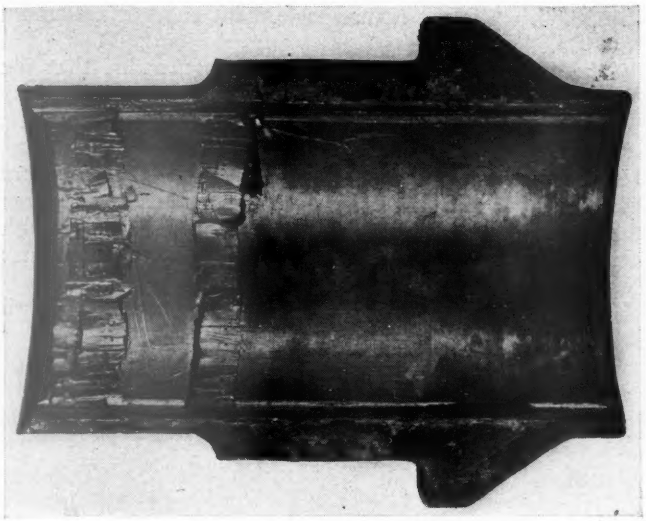


Fig. 8—Isn't this something! Two channels were chiseled in the bearing to relieve a cut-journal condition

Fig. 4—This illustration shows a badly cracked or shattered lining on a bearing removed from a car a few months after periodic repacking of boxes. A slight crack is not always visible in ordinary inspection, yet here we have a typical case of progressive cracking resulting from the hydraulic pressure exerted between the lining and shell when once a slight or small crack appears. Obviously we would be well repaid for any extra time spent in a closer inspection of bearings at the time journal boxes are repacked.

Fig. 5—Here we show another case of a loose lining.

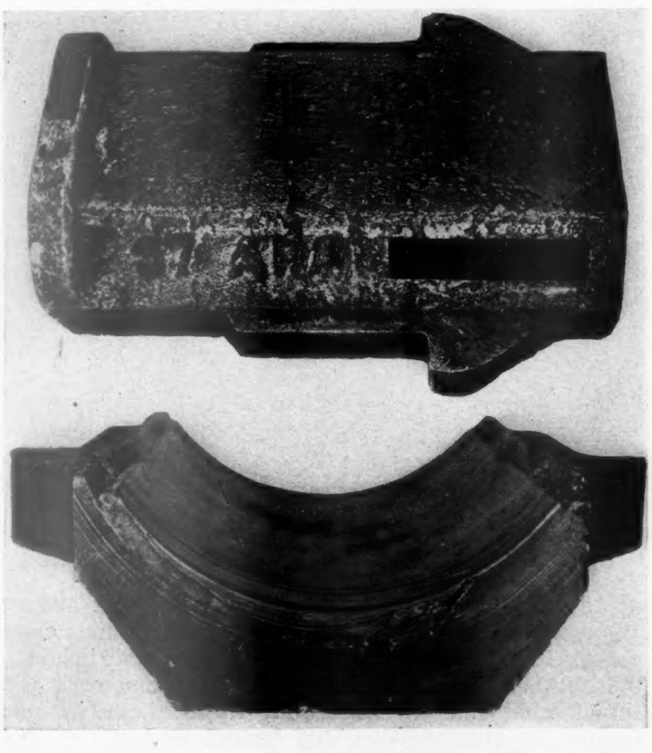


Fig. 9—This brass was applied even though it did not fit the wedge—Evidence is shown of a cut journal

The question which arises is: In our examination are we properly testing the bearings to assure ourselves that the linings are not cracked or loose before reapplication to the box? Try the simple hammer test and see how a light tap on the back of the bearing will reveal a trace of oil in the babbitt metal if a crack is present in the lining.

Fig. 6—This wedge of obsolete design was removed from an overheated journal under a car that had been recently repacked. Note on the back of the wedge the uneven bearing surface where it contacted the ceiling of the box. A crack appears to be developing crosswise, at the front of the wedge. Do you consider that the party who applied this wedge properly inspected the mechanical details of this box assembly to insure 15 months' operation free from trouble?

Fig. 7—Here is an excellent example of a waste grab—the car inspector's "friend." The inspector may tell you it resulted from rough train handling, emergency brake application, etc., while the yard-master may claim that it was caused by overpacked boxes, or packing otherwise improperly applied. Well, any one of these opinions may be right. The fact remains that the waste grab is a common source of trouble.

Fig. 8—This is an unusual case. Various deductions can be made. The evidence indicates that the journal was found cut in two places and the repairman conceived the idea of chiseling out two channels in the babbitt to avoid contact with that portion of the journal which was cut. This box had been treated with a cooling compound which led to the car being shopped for attention with findings as indicated.

Fig. 9—Some lubricating specialists go so far as to advocate the machining of the top of journal bearings to insure a uniform surface the full length of the bearing. Here we have a case where a bearing had been applied when it was known that it would not properly contact the inner surface of the wedge. In other words, at the very outset this box had an uneven bearing. Note

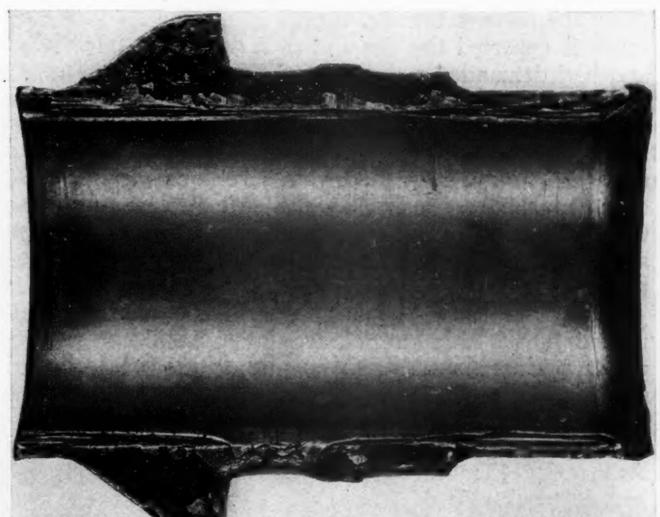


Fig. 10—Brass with lug extensions swedged in, causing the babbitt lining along the side to act as a wiper and rob the journal of its adequate supply of lubrication—An example of carelessness on the repair tracks

from the front view the varying thicknesses of the shell and lining. Yes, this was a 1937 bearing, and if you will observe closely, you will see evidence that the journal doubtless had been cut. In this case the inspector simply applied an A. A. R. defect card and allowed the car to go forward. Such practices invite serious trouble and should be discouraged. Suppose in this case the journal had burned off and extensive property loss resulted. Where would the responsibility rest?

Fig. 10—This bearing was removed when wheels were changed under a car that had been repacked two months

previously. Note where the lug extensions have been swedged in. As a result the babbitt lining along the sides will act as a wiper and rob the journal of its adequate supply of lubrication. The distance across the lug extensions originally measures 5⅝ in., whereas in this case it has been reduced by ⅜ in. This is an example of carelessness on repair tracks, in that a defective bearing was reapplied when boxes were repacked. Could we expect 12 to 15 months satisfactory lubricating performance under such conditions?

Decisions of Arbitration Cases

(The Arbitration Committee of the A.A.R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Truck-Side Damage Caused by Broken Axle

On January 28, 1935, the Wabash delivered an empty stock car, owned by the Quaker City Live Stock Express, to the Chicago and Illinois Midland with a hole worn through the top of the left No. 3 journal box. This hole was caused by the box riding on the stub of a broken journal on a pair of wheels replaced by the Wabash. The C. & I. M. ordered a new truck side from the owners but did render a bill for the part, because it reported the damage as a delivering line defect and had demanded a defect card from the Wabash.

Although the Wabash admitted the truck was damaged on its line and had replaced the wheels without making repairs to the truck side, this road contended that the damage was the owner's responsibility because such damage resulted when the axle broke, permitting the truck side to drop down and let the box ride on the axle stub. Therefore, it refused to issue a defect card to the C. & I. M.

The C. & I. M., having repaired the damage, contended that it was entitled to render a bill for repairs either against the Wabash on authority of defect card or against the car owner, depending on the result of the decision rendered by the arbitration committee.

In a decision rendered on November 12, 1936, the Arbitration Committee stated "As the defect on journal box of truck side developed due to a broken axle, owner's responsibility, the same responsibility applies to the damaged truck side."—*Case No. 1753, Chicago & Eastern Illinois Midland versus Wabash.*

Charges for Arch Bars and Tie Bars Replaced with Side Frames

On September 13, 1935, a car owned by the North American Car Corporation was derailed on the St. Louis Southwestern and was returned to the owner with the delivering line damage covered by defect cards. The arch bars and tie bars were bent, and the owner elected to scrap and replace them with Andrews side frames, charging the St. Louis Southwestern a price equivalent to that for repairing the arch bars and tie bars plus necessary material costs instead of charging for new parts. The charges made by the car owner amounted to $58.66, while the actual betterment charges amounted to $105.84.

The St. Louis and Southwestern contended that the charges should be confined to the work actually performed, and that any increased cost resulting from the application of betterments was the owner's responsibility. However, the owner maintained that its charges were in accordance with the original design and did not exceed the betterments applied, which is in accordance with the first paragraph of rule 94. Consequently, the owner contended that its charges were correct.

The Arbitration Committee's decision, rendered April 8, 1937, stated: "The charge as rendered by the car owner is proper, as it does not exceed the charge for repairs authorized by defect card in accordance with first paragraph of rule 94."—*Case No. 1754, St. Louis Southwestern versus North American Car Corporation.*

Straightening Press for Steel Car Parts

An efficient and powerful steam-operated press used in straightening steel car parts at the Danville, Ill., shops of the Chicago & Eastern Illinois, is shown in the illustration. The steam cylinder, with 22-in. piston diameter and 18-in. stroke is rigidly bolted to a heavy iron framework, the piston operating vertically above a face plate 3 ft. 6 in. wide by 8 ft. 6 in. long and located about 14 in. above the shop floor.

The steel framework supporting the cylinder consists

Steam-operated press used in straightening steel car parts at the Danville shops of the C. & E. I.

of 15-in. channels and I-beams riveted together and set on a solid foundation. The spread of the vertical channels is 10 ft. 9 in. on centers and the overall height is 9 ft. About 40 ft. back of this steel framework is a similar steel frame over a heating forge; these two steel frames are tied together and braced against the shop wall by means of 9-in. double channels riveted together to form an I-beam which also serves as a trolley for the 5-ton chain hoists used in handling the heavy steel parts.

The cylinder is shop-made from a scrap locomotive cylinder bushing with top and bottom heads made of locomotive cylinder heads, held together against the bushing by an adequate number of 1-in. tie rods. The piston and piston rod also are of the locomotive type

with the usual packing rings and packing gland. A globe drain valve is provided in the lower end of the cylinder and the usual steam-operating valve is located on the left channel with a throttle lever within easy reach of the operator.

This steam press is used for the most part in the cold straightening of steel car end sills, side sills, center sills, bulb angles, car ends, stakes, braces, posts and doors. When badly bent, some of these parts have to be heated before straightening and in this case the overhead trolley and chain hoist connection to the forge is very convenient. In the case of bent steel car ends, the corrugations are reformed practically like new by the use of rollers and wedge-shaped straightening dies. Special dies are used for stake pockets and similar parts. It is seldom necessary to use more than two men in the operation of this straightening press, which greatly expedites the handling of steel-car work at the Danville shops.

Questions and Answers On the AB Brake

General (Continued)

243—*Q.—How would you proceed to cut out a brake?* A.—Close the branch-pipe and cut-out cock, and drain both reservoirs completely.

244—*Q.—What should be considered when "picking up" a car on the road having AB equipment?* A.—Because of the use of an emergency reservoir in addition to the auxiliary reservoir, approximately twice the time is required to charge the brake system as compared with the K equipment.

245—*Q.—What would be the result if this fact was not taken into consideration?* A.—Unless sufficient time is allowed for charging, the brake may fail to apply during the road test.

246—*Q.—Where can we expect an exhaust of air to the atmosphere following an emergency application?* A.—At the main exhaust port of the emergency portion.

247—*Q.—How long should this blow continue?* A.—For at least 1 minute, and the brake should not be considered defective unless the blow continues longer than 2 minutes.

Cleaning, Lubricating and Testing

248—*Q.—Should the service or emergency portions be cleaned on or at the car?* A.—No. They should be removed from the car and replaced by portions known to be in good condition.

249—*Q.—What should be done with the portions removed?* A.—After first properly protecting them from exposure to dirt and damage, they should be transported to a point provided with an approved test rack.

250—*Q.—What attention should be given the bracket portion?* A.—It should be blown out with compressed air, and the hair strainer should be removed and cleaned. Note: A recommended practice is to carry sufficient strainers in stock to provide for renewals. The dirty strainer should be placed in the protection cover on the service portion, which contains a receptable for this purpose, and forwarded with the service portion to the shop for repairs.

251—*Q.—When dismantling the portions for repairs or cleaning, what care should be exercised to avoid distortion of bolts, studs, nuts, etc.?* A.—Special wrenches should be provided to fit these parts.

252—*Q.—What further care must be taken when dismantling or assembling the parts?* A.—Damage to pistons, springs, gaskets and slide valves must be avoided.

253—*Q.—What is important insofar as choke fittings are concerned?* A.—The size of the various chokes is important and they should be removed, cleaned and gaged.

254—*Q.—What is a good practice in regard to the cleaning of chokes?* A.—It is preferable to remove the chokes one at a time for cleaning and inspection.

255—*Q.—Why should this procedure be followed?* A.—To avoid mixing, that is, to insure that each choke is replaced in its proper location.

256—*Q.—What is the proper method for cleaning chokes?* A.—They should be dipped in a cleaning fluid and blown out with compressed air; no metallic tools should be used to clean the openings.

257—*Q.—When cleaning the portions, what method should be followed?* A.—They should be completely dismantled and all parts inspected and cleaned; also, all parts should be washed in a cleaning fluid to dissolve any oil or grease that may have accumulated.

258—*Q.—How should gaskets or rubber-seated valves be cleaned?* A.—They should be dipped in a cleaning fluid, if the fluid is noninjurious to rubber; the parts must be promptly wiped dry after dipping in the cleaning fluid. Defective gaskets or diaphragms should be replaced with ones in good condition.

259—*Q.—What attention should be given the springs?* A.—They should be inspected for rust pits or other defects.

Jig for Laying Tight Car Floors

To assure laying freight-car floors which will be tight not only when new but after some shrinkage has taken place, the jig shown in the illustration is used at the Northern Pacific freight-car shops, Brainerd, Minn. The device consists simply of an air-cylinder arrangement (one on either side of the car) which permits applying the last few boards at the center of the car with considerably more pressure than would be possible with hand-laying methods and thus squeezing all of the floor boards together at a predetermined pressure adequate to prevent the subsequent development of cracks.

In applying car decking at Brainerd shops with this device, the boards are laid loosely on the car sills or nailing strips, working from each end towards the cen-

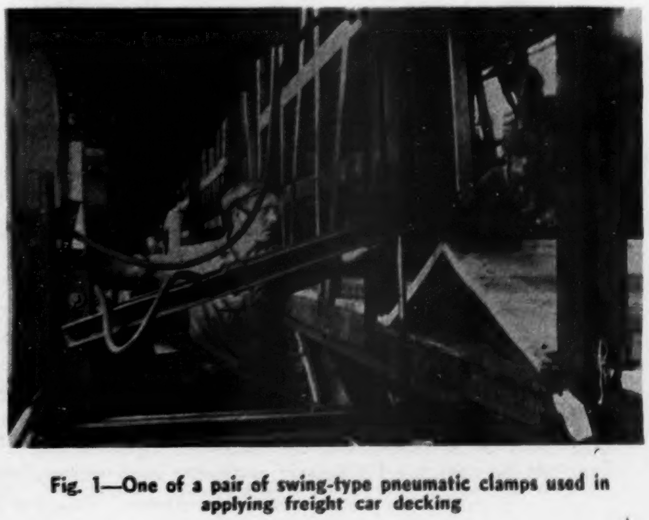


Fig. 1—One of a pair of swing-type pneumatic clamps used in applying freight car decking

ter. These floor boards in each end of the car are then held down against upward movement by 3-in. by 4-in. stringers laid longitudinally on top of the decking and stayed from the car roof. Five floor boards on each side of the car center (and including the additional one or more boards inserted for tightening purposes) are then cleated together and placed in an inverted vee position as shown in Fig. 1. A suitable wooden block is applied at the point of the vee and the air clamp swung into position with the lower jaw under the car side sill and the upper jaw resting on the block.

A similar clamp is applied on the other side of the car and, when the operating valve is opened, air is admitted to both cylinders simultaneously, drawing the two jaws of each clamp together and having the immediate effect of gradually flattening the V-shaped boards and pressing all floor boards in the car together until the vee finally is forced into a horizontal position as shown in Fig. 2, with one extra floor board (or more as required) applied. The decking is nailed lightly at intervals to assure its staying in place; the 3-in. by 4-in. stays are removed; and the final nailing operation is completed, using 3-lb. double hand hammers which not only drive the nails easily in about two blows but have sufficient weight to force the decking down against the car sills.

Referring again to the illustration, the construction of the pneumatic jig will be apparent. The jaws are made of small angles pivoted at the left ends to a vertical steel plate and round bar which is mounted in two substantial eye brackets, rigidly secured to the shop walls. This arrangement permits swinging the jaws parallel with and close to the walls when not in use and thus avoids obstructing the passageway.

The air cylinder, with a 5-in. bore and 24-in. stroke,

Fig. 2—View of the decking after it has been pushed down, with all boards tightly in place

is mounted near the end of the upper jaw by means of a pivoted connection and has a piston rod connection to the lower jaw which is also pivoted to permit angular movement. The weight of the air cylinder and outer jaw ends is supported when the jig is not in use by means of a 1-in. diagonal rod with pin connection at the upper left end to the vertical steel supporting plate and a slotted connection to a pin in the lower jaw which adds to the flexibility of the device. In other words, this construction permits the lower jaw to adapt itself to car side sills of slightly varying height.

A similar pneumatic clamp is provided on the other side of the car, both operated by air from a single valve.

* * *

Automatically operated eight-car AB brake endurance test rack of the New York Air Brake Company

At the right is a U2 Mercury manometer which registers application and release differentials of the AB valve. In the center is the control mechanism for automatically charging and reducing the brake pipe in one-minute cycles. In front of the valves are 10-in. by 12-in. diameter cylinders. Otherwise the brake equipment is the same as used on freight cars.

IN THE BACK SHOP AND ENGINEHOUSE

Motor-Driven Sheet Metal Shears

An unusually efficient and convenient type of motor-driven sheet metal shears, which was made and is now being used at the Danville, Ill., shops of the Chicago & Eastern Illinois, is shown in the illustration.

The frame of this machine is constructed of angles

Shop-made sheet metal shears used at the Danville shops of the C. & E. I.

welded together and designed to support rigidly the shearing unit and a large table made of 3/8-in. sheet steel. The U-frame which carries the cutter shafts is a welded, built-up structure made of heavy tank steel. The two cutter shafts, mounted one in the upper and the other in the lower jaw of the machine are equipped with roll cutters at the outer end which, when brought together serve to shear sheet metal sheets quickly and easily to any shape or design required. The cutter shafts are gear-driven from a 1½-hp. electric motor mounted in the base of the machine.

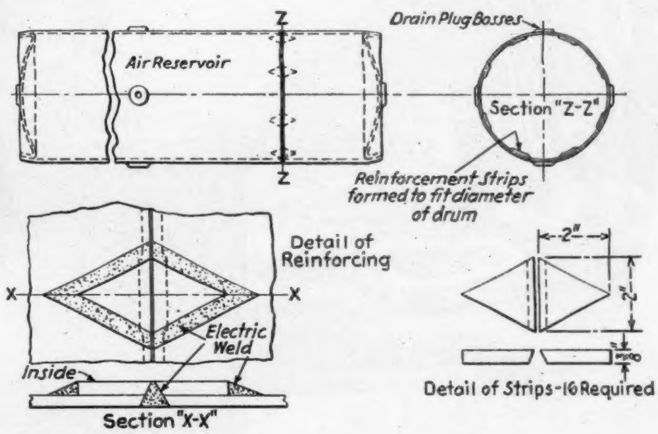
The work done on this machine is primarily locomotive jacket work. However, other light sheet metal parts, such as stove pipes, galvanized spouting, and galvanized material for various utensils, are cut on this machine. The machine is used to make both straight cuts and circles with a comparatively small radius.

Prior to the adoption of this machine, all jacket and light sheet metal parts were cut with a large pair of hand shears. This machine has eliminated the use of the large hand shears, and results in a saving of approximately 20 per cent in labor cost in preparing and cutting a locomotive jacket.

Changing the Size Of Air Reservoirs

Locomotive main air reservoirs sometimes have to be lengthened to provide increased capacity or possibly shortened to fit in a restricted space. In either case, the method illustrated may be used to good advantage, as it involves the welding together of two reservoir sections of any desired length by means of a reinforced circumferential seam which gives equivalent or even more strength than in the original reservoir.

Referring to the drawing, the general method of preparing and welding this circumferential air reservoir seam is shown. The edge of each section of the reservoir is beveled to an angle of about 30 deg., and diamond-shaped reinforcement strips are cut in two, beveled and electrically welded to the inside of the reservoir, being spaced as shown and applied before the reservoir sections are placed in position for welding. The reinforcement strips are made of 3/8-in. boiler steel of the shape indicated and formed to fit the inside diameter of the reservoir. Sixteen reinforcement strip pieces in all are required and they are spaced on each side of the



Details for preparing and welding the circumferential air reservoir seam

drain plug bosses as shown, to permit the reservoirs to drain properly.

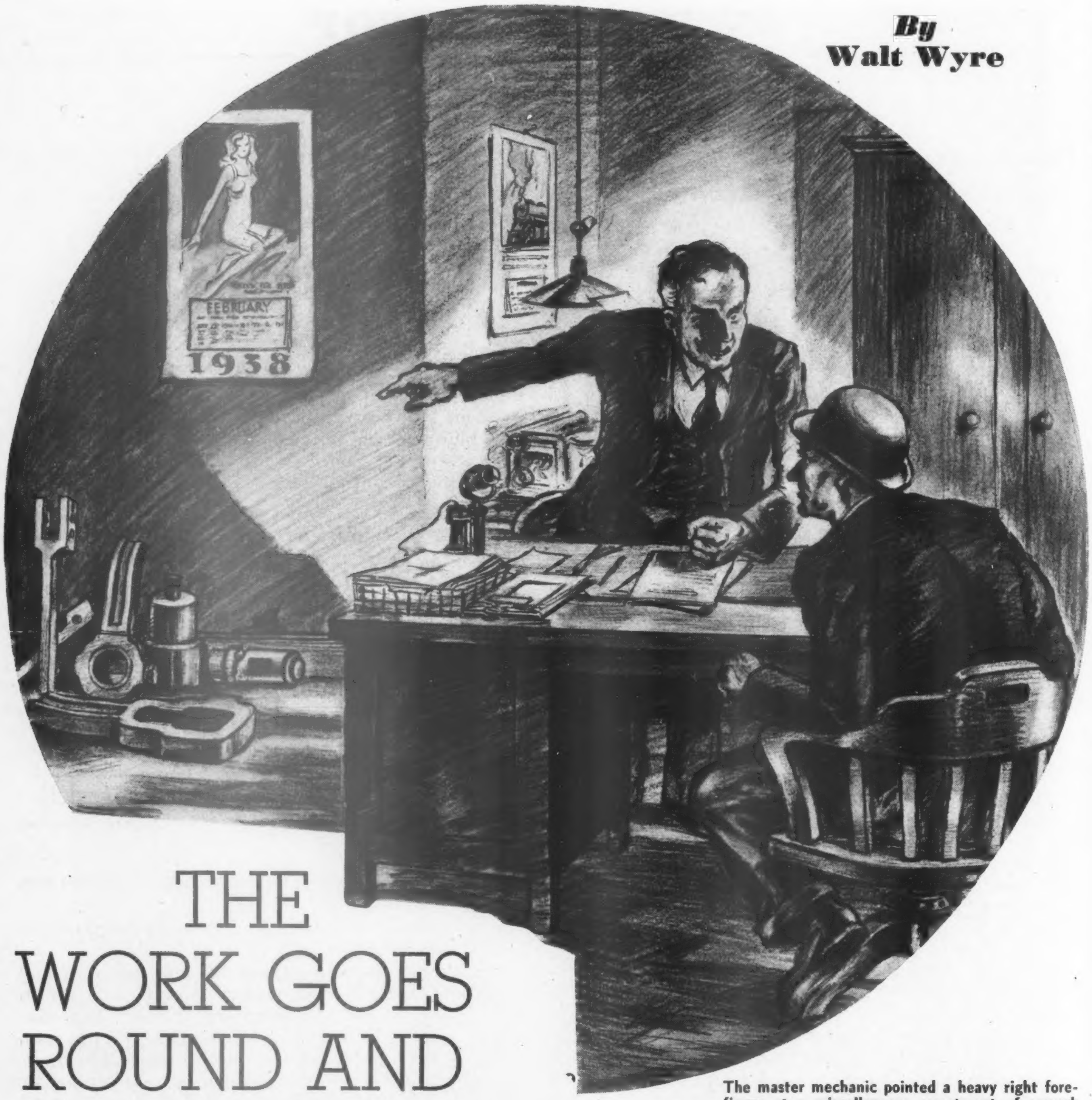
After the air reservoir sections are lined up accurately in position they are tack welded on opposite sides to prevent them from being drawn out of line. The reinforcement strip pieces are welded together and the seam finished smooth and flush with the outside of the reservoir. This method of lengthening and shortening air reservoirs may, of course, be used with equal success on all types of cylindrical reservoirs and drums.

Power Chucking Wrench

The Cushman Chuck Co., Hartford, Conn., recently developed a uniform-torque power wrench for production chucking of pieces in lathes, drill presses and milling machines which is designed to lessen the fatigue on the operator and to produce a uniform chucking pressure for eliminating distortions usually due to unequal pressures on chuck jaws when tightened by hand. The power wrench includes a high-torque constant-speed reversible motor, a reduction gear and a splined drive shaft. One end of the drive shaft engages the chuck-

(*Continued on page 77*)

By
Walt Wyre



THE WORK GOES ROUND AND ROUND

The master mechanic pointed a heavy right fore-finger at a miscellaneous assortment of enough scrap steel in one corner of the office to start a fair size junk yard

"EVERY one of the failures could have been prevented!" H. H. Carter, master mechanic on the Plains Division of the S. P. & W., pounded the desk to emphasize his statement. "Not only could they have been prevented, they should have been!"

Jim Evans, the roundhouse foreman, squirmed uncomfortably. "But Mr. Carter—"

"No buts about it," Carter interrupted. "They should have been prevented—old breaks, every one of them!" The master mechanic pointed a heavy right forefinger at a miscellaneous assortment of enough scrap in one corner of the office to start a fair size junk yard.

In the pile of parts were pieces of combination levers, the end of a main rod, a broken eccentric rod, and various other parts of locomotives. Each piece represented an engine failure. Each part under the constant hammering and pounding of a heavy working locomotive had given way. As the master mechanic had said, the broken sections all indicated that the breaks had started from old cracks. In most cases, the break had progressed from a crack at a corner of the piece. The master mechanic leaned over and pointed at the broken end of an eccentric rod.

"Look at that—nearly a third old break! The inspectors should have found that."

"It's sometimes pretty hard to see a crack," Evans

said defensively. "Sometimes they're on the back side."

"They've got mirrors," Carter cut in. "We've given them mirrors, flashlights, and magnifying glasses, and they're supposed to have good eyes, but that's not the point. The point is I want such failures to stop. They've got to stop!" Carter pounded the desk again.

"We'll do our best," the foreman replied.

"I don't care what you do or how you do it, but I don't want any more failures from broken rods." The master mechanic picked up a letter. Evans took the hint and left.

When Evans reached the roundhouse he located the laborer that wipes the rods. "I want all of the rods cleaned and whitewashed every trip," the foreman told the laborer. "After they're whitewashed and inspected, clean them off. I'll give you another man to help you."

The campaign to reduce failures from broken rods was on. The roundhouse smelled like a pre-prohibition cooking plant, the odor of alcohol was so strong.

The whitewash was a mixture of powdered whiting and alcohol. It dries quicker than when mixed with water, and Evans claims makes a finer grained whitewash that shows up cracks better.

Every rod that showed symptoms of the tiniest hairline crack was taken to the blacksmith shop and treated. Hardly a locomotive was turned without some part being thus treated.

Some were cracked, others had, as the blacksmith expressed it, "equators" because the lines were imaginary.

Every one in the roundhouse became crack conscious from cellar packer to cab man. Even the jacket wipers took a look along the side of every engine they passed looking for cracked rods.

The intensive effort brought results. The epidemic of broken rods was stopped, for the time, at least. There was another and less pleasing result. Every one was so busy looking for cracks, little time was left for other work.

Machinists were busy removing and replacing suspected or guilty parts. Laborers were busy whitewashing and cleaning. The blacksmith fire usually had a crack suspect heating in it. Inspectors only needed a Sherlock Holmes hat and calabash pipe to be taken for detectives looking for clues.

One morning Evans was making out his engine lineup when the messenger brought in a wire. "Pink one for you, Mr. Evans," the messenger said.

Messages on ordinary yellow paper are bad enough, but ones on pink usually mean trouble. This one was no exception: "Engine 5086 held at Sanford by federal inspector account worn driving boxes and rod bushings." The message was signed with the initials of the master mechanic.

The foreman dropped the pink slip on the desk like it had burned his fingers. He finished the lineup hurriedly and headed for the roundhouse.

The 5079 was on the drop-pit and had been for over three weeks. Since the campaign against cracked rods started, machinists had little time for dead work. Even the ones assigned to the drop-pit were pressed into service occasionally to help out on running repair.

Evans found machinists Jenkins and Cox, assigned drop-pit men. Both nut-splitters were working on running repairs.

"Let's get on the 5079 and get it out right away," the foreman told them. "Soon as we get her out, two or three other engines have got to go over the pit."

The master mechanic returned to Plainville next day. He called the foreman to the office and lectured long and loud. "There's no excuse for allowing locomotives to be run with driving boxes and rod bushings worn past the limit," the master mechanic began and ended his lecture.

Evans assured him that it would not be allowed to happen again.

AND the campaign against worn bushings and brasses was on. An additional machinist and helper were assigned temporarily at the drop-pit. A machinist put in eight hours a day turning driving box brasses. The crank pin grinder that had been idle for many weeks began making the sparks fly truing up tapered and out of round pins. Driver journals were rushed to the wheel lathe to be turned.

The sudden increase in consumption of brass was so great that the storekeeper suggested that a brass foundry should be added to the S. P. & W. facilities at Plainville.

Extra work incurred putting boxes and bushings in condition took a lot of time that had previously been used in the crack clean-up campaign. Inspectors met incoming engines on the lead and carefully checked driving box pound while the hoghead or hostler pumped them. Magnifying glasses were not used as assiduously. Long lining bars became bright from constant use by inspectors using them to test wear in rod bushings by lifting the rods.

Rome wasn't built in a day, neither can a locomotive in a roundhouse be run over the drop-pit, have the drivers dropped, crown brasses renewed, journals and pins trued, and other work incidental to such procedure be accomplished in eight working hours. Everything considered though, exceptionally rapid results were obtained in the work at Plainville.

With so much of the work being done, many timesaving methods were evolved. Some short cuts were suggested by the foreman, but a larger number were ideas of the mechanics doing the work.

A minor but irritating outcome of the wholesale renewal of bushings and brasses was a sudden increase in the number of hot pins and boxes. When possible, locomotives just off the drop-pit were broken in by being run on a local. A couple of them were used one day each in the yards switching but the hogheads on the goat yelled their heads off about using road engines for switching.

Sometimes conditions didn't allow time for properly breaking in the new bearings. In such cases they were limbered up a little by running them up and down the lead. Liberal doses of oil and crater compound were given the pins and journals. Extra cakes of grease and sticks of pin dope were given the engineer along with the fervent hopes of the foreman that the engine wouldn't run hot.

Except for the minor annoyance of occasional hot pins and journals, everything was going good at Plainville until the cylinder fell off the 5091.

WAS that a mess! The engine right off the drop-pit had made one trip on the local, made a good trip, too, only the right main pin ran a little hot. The hogger didn't have to put water on a single journal.

The next trip was on 71, the fast Gold Ball freight. Forty miles out of Plainville the cylinder dropped off. Traffic was tied up four hours getting the engine and train off the main line. The superintendent, trainmaster, and master mechanic prized up more hell than old Nick ever heard of and that was only the beginning. The superintendent of motive power and general manager took out a few chunks by wire, then went to Plainville for a personal appearance.

"Didn't you know the cylinder casting was cracked?" the master mechanic asked Evans.

"Sure," Evans replied. "I knew it was cracked but I didn't think it was bad enough to do any damage. Half of the engines running out of here have cracks in cylinder castings that look as bad as that one did. I thought—"

"If you had thought," the master mechanic cut in, "you would have tied the engine up until the casting was repaired."

The official didn't intend to be personal, he was only passing on to the foreman a little of what he had received a lot of from the officials over him.

"Well," Evans shoved his chew of "horseshoe" into his cheek with his tongue, "maybe we had better go over all of the cylinder castings and get the ones that might cause trouble welded."

"Of course we should," Carter said before he realized that he was assuming responsibility with the foreman. Then he added, "All right, I'll go over them with you and we'll decide which ones should be repaired."

Every engine that came in was carefully inspected for cracked cylinder castings. Inspectors marked cracks they found with yellow keel. The foreman and master mechanic then examined them and decided what was to be done.

Some were chipped out and welded with bronze. Some were re-enforced with studs before being welded. Ones that didn't look too bad were pronounced O.K. for service but with the understanding that they would be carefully watched. One engine, the 5077 was sent to the back-shop to have the cylinder castings renewed.

Things went along fairly quiet at the Plainville roundhouse for some time. Evans was beginning to feel that his wasn't such a bad job after all until one morning the federal inspector dropped in unannounced as federal inspectors have an annoying habit of doing.

Evans had just picked up a piece of yellow clip and read the short but sweet typed line "engine failures—blank" when the federal inspector came in. The foreman took a deep breath and managed an outwardly cheerful "good morning."

The inspector returned the greeting with a hand-shake, then stepped into the foreman's private office and put on a suit of unionalls.

The 5092 was standing on the lead called for the Limited. The engine crew was already on her.

"Sit down," Evans invited cordially when the inspector came back into the main office. "Have a smoke."

The inspector took the cigar but didn't sit down. "Thanks," he replied, "I'll smoke this after while; guess I'd better work a little now."

The inspector edged towards the door, the foreman reluctantly followed. "What's that going on?" the inspector indicated the 5092.

"The Limited," Evans replied.

"Let's look at her," the inspector said in a matter-of-fact tone.

Evans had little apprehension as they walked towards the locomotive. Of course the engine wasn't perfect, but she was in pretty good shape.

The federal inspector walked around the engine in what appeared a very casual manner. "Looks like that main driver tire flange is a little sharp," the inspector commented in an equally casual manner.

"I'll get a gauge." Evans turned towards the office.

"Never mind." the inspector said, "I've got one."

The tire didn't take the gauge, but what it lacked was so little that Evans held his breath while it was being tried. One more trip would be enough to finish it.

"I'm going to turn the tires when she gets back," the foreman said.

"Good idea," the inspector commented.

The 5092 was not the only engine that had badly worn tires. Others were equally bad and the 5083 that Evans was figuring on running west that night was so bad that the foreman marked up another engine.

He hadn't realized that tires on so many engines were getting in bad shape, meaning both condition and contour. It didn't seem like any time since most of the engines had been over the drop-pit. At that time all that were too bad had been renewed or turned, and most of them needed attention again.

The federal inspector didn't tie up any engines. He reported a few defects, most of which could be remedied without a lot of trouble. Before leaving, however, he did again casually mention the condition of driver tires, very casually, but Evans took the hint.

Once more the drop-pit was a busy machine and the wheel lathe running steadily eight hours a day. The smell of burning paint hung heavily on the roundhouse and the clang of striking sledges hammering hot tires a familiar sound as tires too thin to turn were replaced.

As the crusade against broken rods had given way to the brass brigade, the cracked cylinder campaign gave way to the war on tread worn tires.

If the job of running a roundhouse were merely a matter of correcting certain conditions and they would stay corrected, a foreman's job would be the sinecure some folks think it is. If to paraphrase what Bill Shakespeare said long ago, if it were done when it is done, the sooner the better, or something like that.

But railroading is not like that. A roundhouse job is more like that of the guy that landed the job of killing the Hydra, a fierce serpent with a lot of heads some say seven, but more recent accounts make it nine heads the serpent had. Anyway, every time one head was cut off, two more showed up in place of the one cut off. Hercules—the guy's name was—would have made a good roundhouse foreman because that Hydra didn't have a thing on a roundhouse. Get one job done and you think it's done for good, up pops two more waiting to be handled. It's just like the Hydra another way, too. The job that's biting at you the hardest at the moment is the one that must be chopped off.

Whitewashing rods every trip had long since been not exactly forgotten but rather neglected for lack of time when the federal inspector suggested that some of the tires needed attention. Efforts were made to continue eternal vigilance against broken rods, but with other jobs needing attention worse, Evans just kinda let it slide.

Rods had been whitewashed at the end of every round-trip at first. Then locomotives needed badly were allowed to make a trip without it. Get them next trip, they figured. Sometimes they did, sometimes they didn't, until slowly but surely they got back to the old practice of whitewashing only on monthly tests.

THEN wham!—the 5088 broke a main rod—broke off right up close to the back end—tore up a lot of the valve motion, knocked a head out of the cylinder and broke the guide yoke. Besides doing a lot of damage that cost a lot of money to repair, the crack passenger train was held nearly three hours waiting for an engine.

Two days later the 5091 snapped an eccentric rod. It didn't do as much damage, but was a nasty failure.

Again the master mechanic called the foreman to the office. "Those failures could have been prevented!" the master mechanic said emphatically. "Look at 'em! Old breaks! There's no excuse for such failures."

"But—" Evans started to reply, but Carter cut him short.

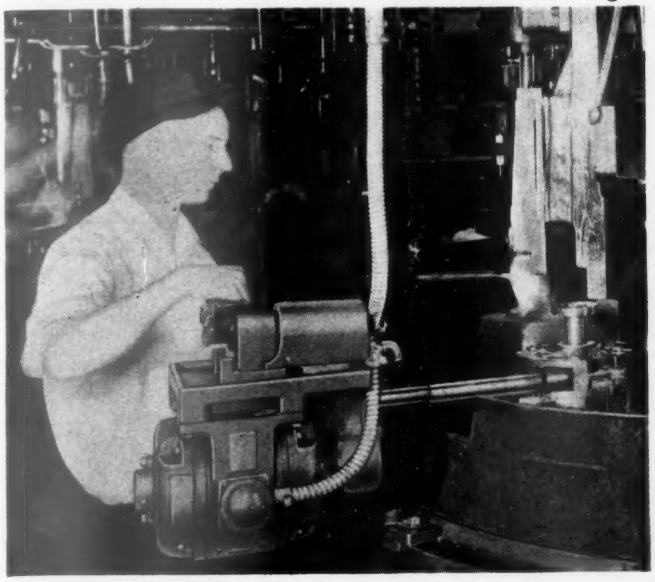
"No buts about it! Such failures have got to stop!"

"Yes, sir," Evans agreed, and the campaign was on against cracked rods, and so on ad infinitum.

Power Chucking Wrench

(*Continued from page 73*)

ing wrench through a suitably formed socket. The other end of the shaft is splined to permit horizontal adjustment of the shaft for various diameters and positions of work. The control button for the motor is mounted in the splined end of the shaft. The entire unit is mounted on the bed of the machine by a bracket



An application of the Cushman power chucking wrench

on which the wrench can swivel, so that if the operator should leave the wrench in the chuck no harm will result when the machine indexes.

The propelling power of the standard wrench manufactured by this company is based on utilizing a motor with a torque of 24 ft.-lb., which is estimated to deliver a driving torque of approximately 300 ft.-lb. at the end of the splined shaft. However, units which produce 8 ft.-lb. and 16 ft.-lb. motor torque for lighter work can be built to specifications. The torque thus provided by the chucking wrenches makes it possible to attain uniform gripping pressures of the chuck jaws, an obvious advantage in production work, especially where machined parts are finished to micrometer sizes.

Valve- and Cylinder-Bushing Applicator

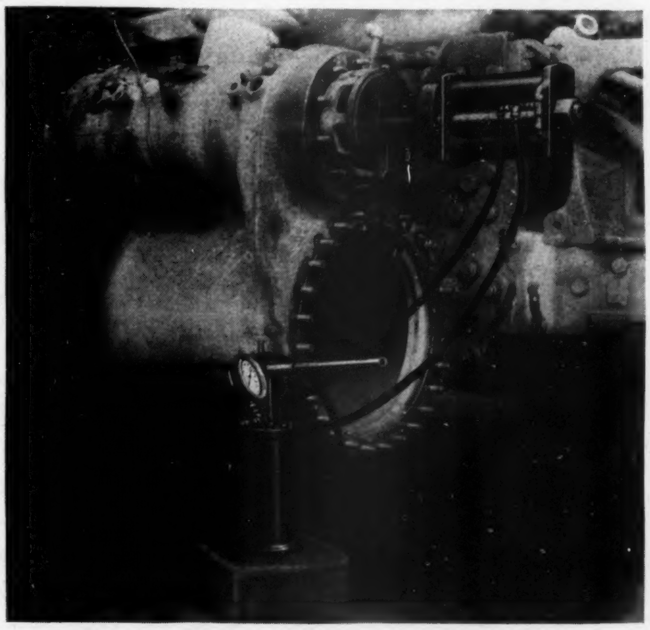
The cylinder-bushing applicator illustrated, which is a light, compact and efficient unit, has recently been developed by the Portable Hydraulic Equipment Company, Chicago, Ill., for use in applying locomotive valve and cylinder bushings by hydraulic pressure. The complete unit, which can be easily handled, set up and operated by one man, consists of an oil-operated, four-speed hydraulic hand pump, and bushing applicator press of 35 tons capacity.

The Rodgers hand pump is built into a housing which serves as a reservoir for five quarts of oil and supports the pump head. The cylinder and valve are made in a single unit of bronze, being attached to the housing base and equipped with ball-type suction and discharge valves. The piston is a ground fit in the cylinder and no leather or other packing is used. The shift block on the pump head is combined as a unit with the operating handle. A simple patented device is said to provide instant control of leverage speed changes.

Under normal operating conditions one man can produce 4,000 lb. pressure on high speed (short leverage) or 10,000 lb. on low speed (long leverage). At 30 strokes per minute on high speed, a 2½-in. stroke of the pump piston produces a volume of approximately 60 cu. in. of oil. At low speed, a ½-in. stroke produces a volume of 12 cu. in. of oil. The pressure hose is metal lined, and tested at 22,000 lb. per sq. in. The return hose is oil proof. The pump is equipped with a gage indicating pressures in pounds and tons.

The double-cylinder press is a simple arrangement of two cylinders fitted with suitable pistons, cover plate and crosshead. The outer ends of the cylinders are welded to a single base plate. The crosshead, cover and base plate have a 2$\frac{1}{16}$-in. hole in the center of each, with a cylinder on each side, this construction allowing the press to slide on the center bar in such a way that the press may be anchored by a base nut in any desired position on the center bar. The ram travel is 12 in., and the combined capacity of the two cylinders 35 tons.

This bushing applicator applies valve bushings simultaneously and is equally effective in applying cylinder bushings. The device eliminates the need for power



Hydraulic valve and cylinder bushing applicator

equipment, such as electric or compressed-air motors and the use of cranes for handling heavy parts. The operator can read and control the pressure accurately during the operation.

Fan-Cooled Motors on Hammond Grinders

Hammond Machinery Builders, Inc., Kalamazoo, Mich., has equipped all of its grinders of 3 hp. and over with totally enclosed fan-cooled motors. The rotor and stator on these units are in an enclosed chamber sealed against the entrance of foreign matter. Two fans force cooling air around the outside of this chamber, serving to ex-

tract heat from the motor. The fan-cooled type motor is said to withstand greater overload with a lower temperature rise. The company's grinders are equipped with automatic starters with thermal overload protection, oversize ball bearings, adjustable eye shields made of shatterless glass and pushbutton remote control.

Hammond heavy-duty grinders especially adapted to service in railway shops, are available as equipped with totally enclosed fan-cooled motors in sizes of 5, 7½ and 10 hp. type WH.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Boiler Cracks at Waist-Sheet Angles

Q.—What causes the shell of a locomotive boiler to crack at the waist-sheet angles? Can it be remedied?—M. E. D.

A.—The practice of securing waist-sheet angles to the boiler shell with studs of rivets affects the normal and equal expansion and contraction of the shell. When applying riveted angles to the shell, such as the waist-sheet angles, the shell plate becomes more rigid at the point of application than the surrounding area and, due to the expansion and contraction of the boiler sheet, stresses are set up in the plate around the waist-sheet angle caused by the rigidity of the construction at this point. These angles, to which the waist sheets and the guide-yoke sheets are attached, transmit stresses and strains set up in the frames, by the running gear, to the boiler shell directly.

Boiler steel has a high tensile strength and such material is less homogeneous and pliable than material of lower tensile strength; for this reason, it is unable to absorb the stresses transmitted through the waist sheets. The shell course generally cracks and falls at or near the ends of the angles due to the tensional stress at these points which is caused by unequal expansion and contraction. The best remedy is to cut the waist sheets loose from the boiler and apply a liner riveted to the outside of the shell between the shell and the waist-sheet angle, thus preventing the waist-sheet angle from wearing into the shell plate.

Bulges in Front Tube Sheets

Q.—What causes the front tube sheet to bulge? Should the front tube sheet be straightened at each shopping?—M. L.

A.—The bulging of the front tube sheets of a locomotive boiler can be attributed to several causes. The most common are:

(1) An improper fit of the tube sheet in the shell of the boiler, whether it is too large or to small, will cause considerable bulging immediately after the boiler is put into operation. When the sheet is too tight it will bulge in and when it is loose it will bulge out.

(2) The rolling of the flues in the tube sheet is the most common cause of the tube-sheet bulging. When using hand rollers, each tube hole is expanded 0.007 in. With a self-feeding roller and an air motor the holes are stretched 0.021 in. The rolling operation, considering the number of tube holes in a tube sheet, results in a considerable outward stretch in the sheet toward the shell of the boiler, where the outer rim of the tube sheet being solid refuses to permit any more movement in that direction, thus causing the tube sheet to bulge.

(3) The expansion and contraction of the boiler tubes puts considerable strain on the tube sheets, and although this condition is generally taken care of by the use of copper ferrules in the rear tube sheet, the practice of seal welding the tubes often defeats the purpose of the ferrules, causing the tube sheets themselves to take the load due to expansion and contraction. Obviously, the tube sheets will bulge under these conditions.

Some shops straighten the tube sheet with a bar bolted across the flue sheet, pulling the sheet up to the bar. However, the general practice is not to straighten out the bulge at each shopping, most of the front tube sheets lasting the life of the boiler.

Mean Effective Pressure Defined

Q.—What is meant by the term "mean effective pressure" and what relation does it have to the boiler pressure of the locomotive?—B. B.

A.—The term "mean effective pressure" relates to the pressure in the cylinders and is the average useful pressure which does work in the cylinder; it is the average pressure exerted on the piston, throughout its stroke, and is calculated from the average of ten ordinates on the indicator card or by means of the planimeter.

It has no direct relation to the boiler pressure except that the boiler pressure, minus whatever loss occurs between the boiler and the cylinders, is the initial pressure upon which mean effective pressure is based.

Cause of Cracks in Tube-Sheet Knuckles

Q.—What causes cracks in the knuckles of the back tube sheets and what can be done to prevent these cracks?—D. E. D.

A.—Cracks in the knuckle of the back tube sheet are caused by the working of the tube sheet, due to the unequal expansion of the boiler shell, the boiler tubes and

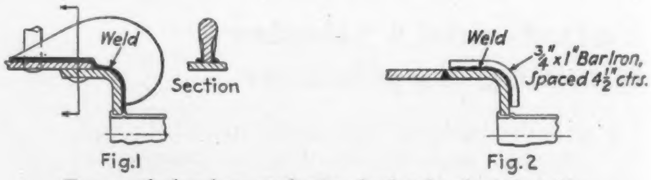


Fig.1 Fig.2

Two methods of strengthening back-tube-sheet knuckle

the firebox. Various methods are used for strengthening the knuckle of the back tube sheet to prevent such cracks. The two most common are shown in Figs. 1 and 2. Fig. 1 illustrates a specially designed reinforcing rib welded in place as shown on a 4 to 6 in. pitch. Fig. 2 illustrates a bar-iron reinforcing strap welded in place as shown. The purpose of the reinforcing ribs is to stiffen the knuckle so that the sheet, rather than the knuckle will take up the expansion.

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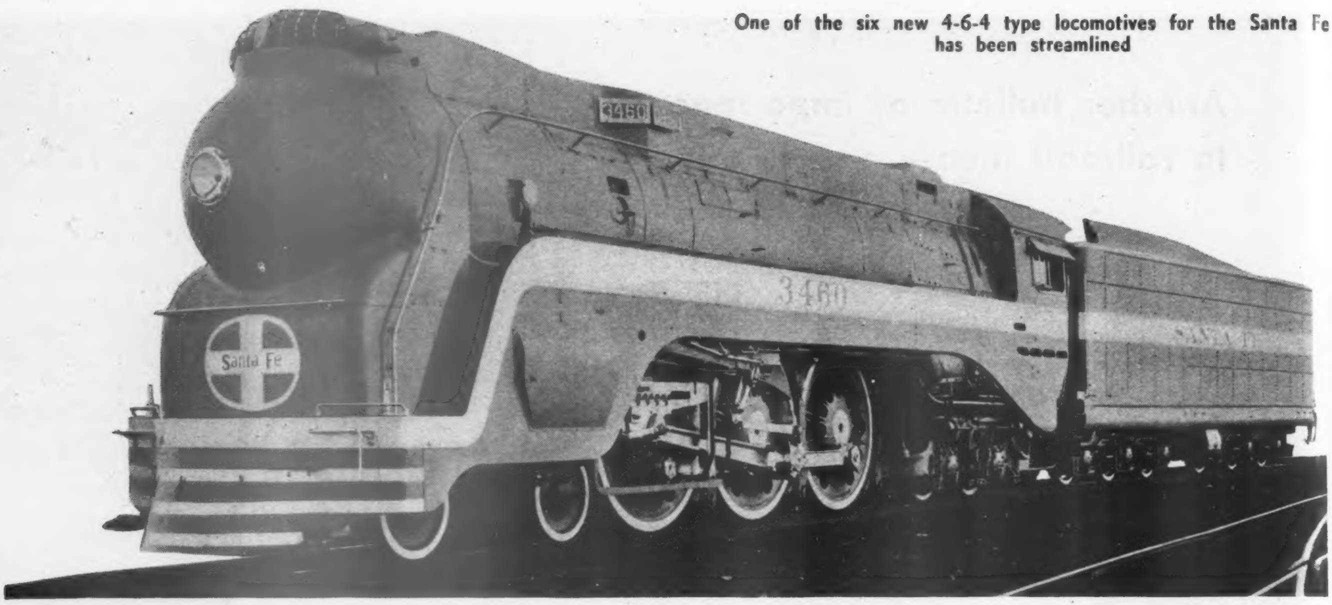

One of the six new 4-6-4 type locomotives for the Santa Fe has been streamlined

NEWS

Improvement Programs

The Missouri Pacific has prepared plans for improvements to 9 of the 12 engine stalls in its enginehouse at 14th and Pinkney streets, Omaha, Neb. Each stall will be extended 20 ft. Three mechanical draft units and new heating equipment will be installed at a cost of about $45,000.

The Lehigh Valley has asked the Interstate Commerce Commission for permission to borrow $778,000 from the Reconstruction Finance Corporation for repairs and to buy new rolling stock. The company needs to repair 1,460 steel coal cars and would re-employ 300 men to carry out this work at its Sayre, Pa., and Packerton shops.

The New York, New Haven & Hartford has petitioned the court for permission to purchase 50 lightweight streamline passenger coaches, estimated to cost $2,100,000. This will bring the total of this type of equipment on the New Haven to 200 cars. The court was also petitioned to permit the purchase of 10 Diesel-electric switching locomotives to cost $750,000.

Santa Fe Receives Six New Locomotives

The Santa Fe has received from the Baldwin Locomotive Works six high-speed 4-6-4 type oil-burning locomotives, one of which is streamlined, for use in passenger service between Chicago and La Junta, Colo., a distance of 992 miles.

The streamlining of engine 3460, which has a steam pressure of 300 lb. per sq. in., is designed to blend into the contour of the train. The shrouding is painted in two shades of blue, while the underportions of the locomotive and tender, including the running gear, are painted black. An 18-in. stainless-steel strip, on which the words "Santa Fe" and the number "3460" are painted, extends from the front of the locomotive to the rear of the tender on each side at the level of the running board. Other striping is in silver leaf and the faces of the driving wheel tires and hubs are painted aluminum, as are also the tires of all the engine- and tender-truck wheels. Although at present equipped for burning oil, the engine and tender are so designed that coal-burning equipment, including a mechanical stoker, can subsequently be applied if desired.

One of the six new engines in a test run recently hauled the Santa Fe's fast mail train, No. 8, from Los Angeles to Chicago, a distance of 2,227 miles, without a change.

Railroads Ask I. C. C. to Modify Power Gear Order

In the hope of lightening their financial burden during the coming year, the Association of American Railroads has petitioned the Interstate Commerce Commission to modify its order of June 8, 1937, relative to the installation of power reverse gears. The commission's order provided that the railroads should install power reverse gears on all locomotives when they were brought in for class 3 or heavier repairs. The railroads would have the commission modify this order so that they will be required to install the gears when class 1 or 2 repairs are made. The petition calls attention to the fact that prior to the entry of the commission's order, the complaining brotherhood officials and the railroads entered into an agreement providing for the installation of power reverse gears on all locomotives when they were shopped for class 1 or 2 repairs, with all installations to be made not later than January 1, 1942, unless otherwise agreed between the management and the general committees of the brotherhood.

The railroads particularly called attention to the serious financial condition which they are in at this time and pointed out that the installation of power reverse gears will be unnecessarily hastened if the commission's order is followed because of the greater frequency of class 3 repairs. They go on to contend that all locomotives will have to be equipped by 1942 with the result that there is no need at this time to speed up the installations.

156 Fusion-Welded Tank Car

The Interstate Commerce Commission has recently granted applications of five companies for authority to construct a total of 156 fusion-welded tank cars. The largest number of cars was involved in the application of the Union Tank Car Company for authority to build 100 for the transportation of petroleum products. The General American Transportation Corporation was authorized to build 25 and the American Car and Foundry Company 14 for the transportation of anhydrous ammonia, while the former will build another five, nickel-clad, for carrying caustic soda solution. The remaining 12 will be built of chromium steel by E. I. duPont de Nemours & Company for the transportation of nitric acid.

New Research Heads for A. A. R.

J. J. Pelley, President of the Association of American Railroads, has announced the appointment of William I. Cantley as mechanical engineer, Mechanical Division, and G. M. Magee as civil engineer, Engineering Division. Both men will be in charge of research so far as their respective divisions are concerned, according to

(Continued on next left-hand page)

the announcement. This work was formerly under the direction of L. W. Wallace who, on December 1, resigned as Director of the Division of Engineering Research.

Mr. Cantley has had wide engineering experience, having been for the past 20 years mechanical engineer of the Lehigh

W. I. Cantley

Valley. He was born in Philadelphia on July 19, 1883, and was educated in private school and at Drexel Institute. From 1902 to 1915 he was connected with the Engineering Department of the Baldwin Locomotive Works and on November 1, 1915, was appointed assistant mechanical engineer of the Lehigh Valley, being advanced to Mechanical Engineer on March 15, 1918. Since 1927 he has been Chairman of the Committee on Locomotive Construction of the Mechanical Division of the A. A. R.

Mr. Magee since last August had been assistant director of the Division of Engineering Research, A. A. R. Prior to his connection with the Association he was assistant engineer of the Kansas City Southern, where he had wide experience in civil engineering.

I. C. C. Issues Stoker Order

FOLLOWING the recommendations of Special Examiner Homer C. King's proposed report which was abstracted in the October, 1937, issue of the *Railway Mechanical Engineer,* the Interstate Commerce Commission, on December 30, issued an order requiring the railroads of the country to equip approximately 3,500 of their locomotives, used in through service, with automatic stokers. The 30-page report, which was written by Commissioner McManamy who handled the case, gives his reasons for requiring the railroads to install automatic stokers which may be summarized as follows: Bad effects of firebox glare on the eyesight of the fireman, danger from firebox explosions or back fires, poor health caused from exposure of fireman to extremes of temperature, fatigue induced by hand firing, inability of firemen to keep a proper lookout in accordance with operating rules with the resultant danger to employees and passengers of collisions with both trains and automobiles.

The order of the commission states that the use in fast or heavy passenger service of hand-fired coal burning locomotives which weigh on driving wheels 160,000 lb. or more, and the use in fast or heavy freight service, of hand-fired coal-burning locomotives which weigh on driving wheels 175,000 lb. or more, causes unnecessary peril to life or limb, and the safety of employees and travelers on railroads requires that all such locomotives be equipped with a suitable type of mechanical stoker. The order further states that all coal burning locomotives of the stated weights built on or after July 1, 1938, shall be equipped with a suitable type of mechanical stoker and such stokers shall be properly maintained.

The commission will also require all hand-fired coal-burning locomotives of the stated weights used in fast or heavy service, built prior to July 1, 1938, to have a suitable type of mechanical stoker. The order goes on to state that each railroad which operates hand-fired coal-burning locomotives of the stated weights shall file with the Chief Inspector of the Bureau of Locomotive Inspection as of July 1, 1938, a list of all hand-fired coal-burning locomotives of the stated weights built prior to July 1, 1938, which will in the future be used in fast or heavy service on its line, and that mechanical stokers will be applied each 12 months period to not less than 20 per cent of the total number so listed, and that all locomotives of the stated weights which are in those services on each railroad shall be so equipped before July 1, 1943, and that such stokers shall be properly maintained. The commission concludes its order by saying that "for the present our order shall not apply to deckless locomotives equipped with two cabs which are generally known as the 'Mother Hubbard type' built prior to July 1, 1938."

Bearing in mind the fact that it is "extremely difficult if not impossible to meet every operating condition or safety need from a single record," Commissioner McManamy assures the railroads that "if experience shows that the standards here presented are inadequate, or are unnecessarily burdensome, they may be brought to our attention for modification or amplification as the results of the experience may require." He also amplified his decision by saying that the order did not prohibit the use of hand-fired coal-burning locomotives where two firemen are used.

Recognizing that some of the carriers are in a precarious financial condition, Commissioner McManamy states that "Our order has been so drawn and limited as to minimize the expenditures in so far as it can be done without disregarding the safety of employees and travelers." He further asserts that "it is apparent that the cost will be very much less than the amount estimated by the defendants and the benefits to be derived will be substantial." The railroads, in answer to the complaint, had estimated the cost of installation at $115,000,000.

Commissioner Lee, concurring in part, agreed that stokers should be installed on freight and passenger engines in fast and heavy service, but objected to forcing the carriers to install them on locomotives used in local, yard, and branch line service. "As it applies to the latter service," he said, "I do not believe the order can be justified on the ground of safety. Under their present financial condition, the carriers should not be required to make unnecessary expenditures."

Commissioner Eastman dissented from the majority, saying that "The order entered herein will not be a serious burden upon the railroads, because of the long time allowed for compliance and the likelihood that there will be compensation for much of the cost through the efficiency gained by the use of the automatic stokers. My study of the case, however, convinces me that the report of the majority gives most inadequate consideration to the evidence presented by the defendants. I do not believe that the order will contribute materially to the public safety or that it can be justified on that ground." He concluded by stating that he was authorized to state that Chairman Miller joined in his views. Commissioners Meyer and Mahaffie did not participate.

(*Turn to next left-hand page*)

New Equipment Orders and Inquiries Announced Since the Closing of the January Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Chicago & Eastern Illinois	2	600-hp.	Electro-Motive
	1	600-hp.	American Loco. Co.
Chicago, Milwaukee, St. P. & P.	6	4-6-4	American Loco. Co.

LOCOMOTIVE INQUIRIES

Road	No. of Locos.	Type of Loco.	Builder
Alaska Railroad	1	4-6-2	....
Canadian Pacific	10	Hudson	....
Chicago & North Western	3	4-6-4	....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Chesapeake & Ohio	25	70-ton hopper	American Car & Fdry Co.

FREIGHT-CAR INQUIRIES

Road	No. of Cars	Type of Car	Builder
Canadian Pacific	2,000	40-ton box	....
	200	50-ton hopper	....
	200	Stone	....
	100	Gondola	....
	200	Flat	....
Lehigh & New England	50-75	70-ton hopper	....
Northern Pacific	150	Underframes	....

PASSENGER-CAR INQUIRIES

Road	No. of Cars	Type of Car	Builder
Chicago & North Western	2	Passenger-baggage	....
	2	Coaches	....
	2	Room coaches	....
	2	Cafe lounge	....
	2	Dining	....
	2	Observation parlor	....

Supply Trade Notes

E. T. Schroeder, 1205 Syndicate Trust building, St. Louis, Mo., has been appointed sales representative in the southwestern territory for The Burden Iron Company, Troy, N. Y.

J. M. Hall, who has been elected vice-president of the Cardwell Westinghouse Company, Chicago, as announced in the January issue of the *Railway Mechanical Engineer,* was born on February 25, 1887, at Howard, S. D., and was educated in electrical engineering at South Dakota State

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J. M. Hall

college. Mr. Hall first became associated with the railroad field as a draftsman on the Chicago & Alton (now the Alton). In 1909 he entered the employ of W. W. Cook & Son, contractors. In 1911, he returned to the Alton as chief draftsman, and in 1914 he became identified with the Babcock & Wilcox Company as chief draftsman, leaving this company two years later to become superintendent of the Hamilton Steel Wheel Company, Hamilton, Ont. In 1918, Mr. Hall became associated with Dominion Foundries & Steel, Ltd., Hamilton, as general superintendent. In 1923, he became vice-president of the Hall Draft Gear Corporation, Watervliet, N. Y., and three years later he became assistant to the president of the Universal Draft Gear Attachment Company. In 1928, he joined the Cardwell Westinghouse Company as chief engineer, which position he continued to hold until his recent election as vice-president.

C. Irving Lusink, assistant manager at Rochester, N. Y., of the engineering department of The Symington-Gould Corporation and the Gould Coupler Corporation, has been appointed mechanical engineer of the two companies, with headquarters, as formerly, at Rochester.

Walter L. Woody, manager of the Cleveland Works of the National Malleable and Steel Castings Co., Cleveland, Ohio, has been appointed manager of the Sharon, Pa., works. Charles H. McCrea, sales manager at Cleveland, succeeds Mr. Woody as manager of the Cleveland works.

R. J. Van Meter, assistant to the vice-president of the Superheater Company, with headquarters at Chicago, has also been placed in charge of sales and service for the western territories.

A. L. Bergstrom, chief works engineer of The Timken Roller Bearing Company, Canton, Ohio, has been appointed executive engineer to co-ordinate some of the varied engineering activities of the company, following the resignation of Ernest Wooler, chief engineer.

Norman B. Johnson, assistant chief engineer of the Pullman-Standard Car Manufacturing Company, Chicago, has been appointed manager of freight shops, with temporary headquarters at the Pullman Car Works. Mr. Johnson will have general jurisdiction over all freight plant production activities.

Theodore R. Weber, mechanical engineer of the Railway Steel-Spring Division of the American Locomotive Company, with headquarters at Latrobe, Pa., has been appointed chief mechanical engineer, succeeding Alan N. Lukens, deceased, and Bennett Burgoon, Jr., assistant mechanical engineer, has been appointed mechanical engineer, to succeed Mr. Weber.

T. M. Robie, who has been appointed manager of the Diesel engine sales division of Fairbanks, Morse & Co., with headquarters at Chicago, was graduated from the University of Michigan in 1914, where he specialized in the study of in-

T. M. Robie

ternal combustion engines. Later he was employed by the General Electric Company on locomotive tests and on the development of high-speed opposed-piston Diesel generating sets for stationary and Diesel-electric railway locomotive application. For two years he operated Diesel power plants in New Mexico. Upon returning from the World War Mr. Robie became associated with Fairbanks, Morse & Company, during which time he was associated with the New York branch office for one year, and the Dallas office for two years and was employed at the factory on Diesel engine designing, testing and building for nine years. Since 1932 he has been in charge of Diesel sales to resale manufacturers.

Earle A. Mann, district sales manager of the Standard Brake Shoe & Foundry Company, Pine Bluff, Ark., with headquarters at Chicago, has been appointed director of sales at Pine Bluff.

Carl H. Beck, eastern manager of the Westinghouse Air Brake Company, has been appointed general sales manager, with headquarters at the general office, Wilmerding, Pa. Mr. Beck was graduated from the Pennsylvania State College in 1905, as a bachelor of science, and six

Carl H. Beck

years later received the degree of mechanical engineer from the same college. A few weeks after graduation he entered the employ of the Westinghouse Air Brake Company as a special apprentice and served on a number of shop and field assignments until 1907, when he was appointed steam road inspector at the St. Louis, Mo., office. In 1909 he became representative for the Westinghouse Traction Brake Company in St. Louis, a position he held until 1919 when he was appointed special representative of the Safety Car Devices Company at Wilmerding. Mr. Beck's next promotion came the following year when he was appointed assistant eastern manager of the Westinghouse Air Brake Company. In 1932 he was given full responsibility of the eastern district as manager.

A. E. Biddle, recently elected executive vice-president of the Cardwell Westinghouse Company, Chicago, as announced in the January issue of the *Railway Mechanical Engineer,* was born on April 27, 1893, at Chicago, and completed his high-school education at that point. He first became identified with the railroad supply field in 1909, when he entered the engineering department of W. H. Miner, Inc., Chicago. While he was serving with this company, Mr. Biddle took an evening course in mechanical engineering at the Armour Institute of Technology. After spending 10 years in the engineering department of W. H. Miner, Inc., Mr. Biddle was transferred to the sales department, where he remained for another 10 years, his service with this company being interrupted only

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NO. 11 OF A SERIES OF FAMOUS ARCHES OF THE WORLD

Photo by Coxe, Greenville, S. C.

POINSETT ARCH BRIDGE

SOUTH CAROLINA 1820

One of the most interesting of the early bridges in this country is the Poinsett Bridge located at Callahan Mountain, 25 miles from Greenville, South Carolina. This stone arch bridge was constructed under the supervision of Joel Roberts Poinsett in 1820 at which time he was Chairman of the South Carolina Board of Public Works. It is a part of the Saluda Mountain Road and but one of a number of internal improvements which he initiated in his native state. The bridge is 125 feet in length and about 30 feet in height. Parapets on either side rise up some 6 feet. It is in active use today, accommodates one vehicle at a time and the stone work is as sound today as when it was first built.

Joel Roberts Poinsett, was a noted diplomat, statesman and engineer. Widely traveled and a keen student of politics throughout the world, he served successively in the State Legislature, the Federal House of Representatives, was the first American Minister to Mexico, and was Secretary of War under President Van Buren. In 1841 he retired to his South Carolina plantation. The wide variety of his interests is indicated to some degree by his contribution to the National Institute for the Promotion of Science and Useful Arts; his gifts of manuscripts to the American Philosophical Society and the Pennsylvania Historical Society; and the beautiful Poinsettia, which he brought into this country and developed from a Mexican plant.

during the World War when he served 16 months with the United States Army, 11 months of which were spent overseas. In November, 1930, Mr. Biddle was elected

(c) *Moffett Studio*

A. E. Biddle

executive vice-president of the Universal Draft Gear Attachment Company, being elected president and a director of that company in February, 1932. In June of the same year he was elected also vice-president and a director of the Allied Steel Castings Company, and in January, 1934, was elected also vice-president of the Canadian Cardwell Company. In February, 1935, he became vice-president of the Cardwell Westinghouse Company, this position being also in addition to those mentioned previously. In his capacity as executive vice-president of the Cardwell Westinghouse Company, Mr. Biddle retains his connection with the Universal Draft Gear Attachment Company, the Allied Steel Castings Company and the Canadian Cardwell Company.

James C. Younglove has been appointed general sales manager of the American Hair & Felt Company and manager of the railroad and government division of this company and its subsidiary, the Dry-Zero Corporation. Mr. Younglove entered the em-

J. C. Younglove

ploy of the Johns-Manville Corporation in January, 1902. Shortly thereafter he assisted in organizing the railroad sales department of that company. Later he served as a director of the company. On August 1, 1931, he entered the employ of the American Hair & Felt Company as head of the railroad and government division and in December, 1937, was appointed general sales manager, retaining his position as manager of the railroad and government division.

Bard Browne, who has been elected a vice-president of The Superheater Company, New York, as announced in the January issue of the *Railway Mechanical Engineer,* was born at Sedalia, Mo., on February 17, 1887, and in 1904 was graduated from high school. Soon after graduation he entered the employ of the Missouri Pacific at Kansas City, Mo., as a locomotive fireman. Early in 1905 he became a locomotive fireman on the Chicago & North Western, Nebraska and South Dakota divisions, later being promoted to engineman. Desiring to continue his studies, he left railroad work in 1908 to enter school in

Bard Browne

Philadelphia, Pa., at the same time serving a special apprenticeship at the Baldwin Locomotive Works. In 1913 he went to the Antipodes and the Far East as a special representative of the company. Upon returning to America in 1915 he was assigned to duties in the St. Louis, Mo., office and was later transferred to the new erecting shop at Eddystone, Pa. Mr. Browne became associated with The Superheater Company in 1916, and 10 years later was appointed assistant to vice-president, which position he held until his recent election as vice-president.

N. T. McKee, who has been elected a vice-president of The Superheater Company. New York, as noted in the January issue of the *Railway Mechanical Engineer,* was born on January 7, 1882, at Mt. Sterling, Ky. His education was obtained from private schools in Mt. Sterling, and at the University of Kentucky, from which he received the degree of B. M. E. in 1903 and his M. E. degree in 1906. Mr. McKee entered railway service in 1903 as a special apprentice with the Lake Shore & Michigan Southern (now part of the New York Central), finishing his apprenticeship in 1906. In 1906 and 1907 he served as assistant mechanical engineer and then as a locomotive shop foreman on the same road. In 1908 he entered the automobile sales business in his home town, Mt. Sterling, Ky., where he remained until 1911, when he joined The Superheater Company. During 1920-1922, he was assigned to special development work with The Superheater Company, Ltd., of London, an associate company. Shortly after his return from

N. T. McKee

England he became active in locomotive service work and previous to his becoming vice-president he was general service manager of the locomotive division of The Superheater Company.

David F. Austin, manager of sales of the Chicago district of the Carnegie-Illinois Steel Corporation, has been elected vice-president in charge of sales, to succeed C. V. McKaig, who has been elected vice-president of the United States Steel

David Austin

Corporation of Delaware, and has been succeeded by Philip M. Guba, manager of sales at the Detroit district sales office. Mr. Guba has been succeeded by Francis C. Hardie, manager of sales of the Cleveland district sales office, who in turn has been succeeded by F. Royal Gammon. Thomas J. Hilliard, manager of sales of the Pittsburgh district sales office, has been appointed general manager of sales at Pittsburgh, Pa., and has been succeeded by Thomas J. Bray, Jr.

David F. Austin's entire business career has been with the United States Steel Corporation subsidiaries. After leaving Columbia University in 1920, he spent seven

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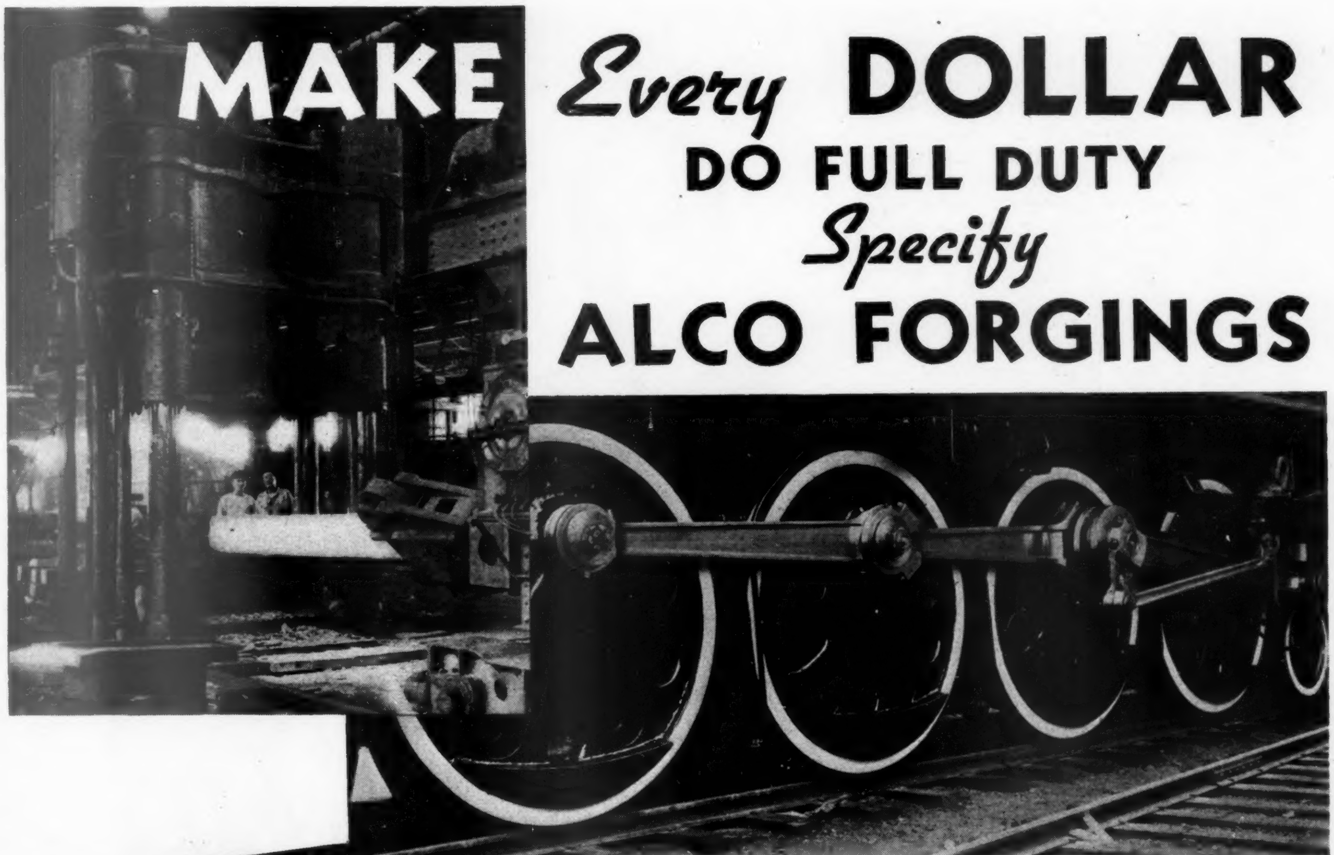

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Specify ALCO FORGINGS

ALL DOLLARS spent for forgings are not equal in value after they are spent. Money spent for forgings, that have demonstrated their ability to last longest in hard service, give utmost protection against engine failures, reduce the cost of running and classified repairs, will unquestionably give greatest return per dollar. That's exactly how ALCO Forgings have performed for many years—they have added dependability to and reduced the cost of operating thousands of locomotives.

ALCO Forgings are economical also, because you get this extra value, strength and durability at less cost than you can equip, maintain and operate your shops to manufacture forgings of similar high quality.

Stick to quality—make every dollar do full duty—specify ALCO Forgings.

AMERICAN LOCOMOTIVE COMPANY

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years in the Youngstown district with the Carnegia-Land Company and the Conneaut Land Company. In 1927 he joined the Carnegie Steel Company's sales department in the Pittsburgh district and shortly thereafter was transferred to Cincinnati, where, in May, 1931, he became assistant manager of sales. In November of the same year he became manager of sales at Cincinnati. Two years later he was appointed manager of sales of the Pittsburgh district office and in November, 1935, was transferred to Chicago, where he became manager of sales of the Chicago district.

Philip M. Guba became associated with the Carnegie-Illinois Steel Corporation in March, 1933, as assistant manager of sales at the Detroit district sales office and was appointed manager of sales at that office in March, 1935. He has been connected with the selling end of the steel industry since 1910, having served 22 years with Jones & Laughlin, the Donner Steel Company and the Republic Steel Corporation prior to his association with Carnegie-Illinois.

Philip M. Guba

Thomas J. Hilliard was born at Pittsburgh on March 3, 1894. He attended St. Paul's school, Concord, N. H., and was graduated from Princeton University with an A.B. degree in 1917. From college, Mr. Hilliard entered the U. S. Army Air Service as a private in May, 1917, and subsequently was advanced to the rank of first lieutenant. He completed his army air service with the rank of captain in February, 1919. Mr. Hilliard was president of the Carhile Petroleum Company of Pittsburgh, from September, 1919, to January 1, 1922; then president of the Pittsburgh Oil & Refining Co., serving in that capacity until 1926, and from January 1, 1926, until June 1, 1930, he was president of the Waverly Oil Works Company, Pittsburgh. From April, 1931, to September, 1932, he was sales manager and vice-president of the O. Hammell Company, Pittsburgh, and then to April, 1935, was vice-president of the Standard Steel Spring Company, Cora, Pa. Mr. Hilliard joined the Carnegie-Illinois Steel Corporation as manager of sales of the Pittsburgh district office, on January 1, 1936, and on January 1, 1938, was appointed general manager of sales.

Thomas J. Hilliard

Obituary

David J. Wilkoff, president of the Youngstown Steel Car Corporation, Niles, Ohio, died suddenly on January 7.

B. J. Morrison, for many years chief engineer of the Coale Muffler & Safety Valve Co., Baltimore, Md., died suddenly on January 2, at his home in Baltimore.

Robert S. Brown, vice-president and treasurer of the G. M. Basford Company, advertising agents, New York, and an advertising executive who was well known in the railway supply field, died unexpectedly at his home in Rutherford, N. J., on January 17. Mr. Brown was 51 years of age at the time of his death and had been connected with the G. M. Basford Company since 1916. He was born in England but came to this country in his early life. After attending public schools of East Rutherford, N. J., and high school, he went to Pratt Institute, Brooklyn, N. Y., where he was graduated in the class of 1909. He then entered the service of the Erie Railroad as a special apprentice, working successively in the Meadville, Pa., office of the mechanical engineer, in the Erie shops at Susquehanna, the office of the general mechanical superintendent at New York and the office of the purchasing agent at New York. He left to become associated with the Simmons-Boardman Publishing Corporation in its advertising production division, and later was engaged in work on the Locomotive Cyclopedia and the Car Builders' Cyclopedia, published by Simmons-Boardman, leaving in 1916 to join the G. M. Basford Company. In recent years, Mr. Brown specialized on merchandising problems in the railway supply industry, including work for the American Arch Company, the Franklin Railway Supply Company, the Lima Locomotive Works, The Superheater Company, the Standard Stoker Company, and others. He was a member of the Engineers' Club, the Transportation Club and the New York Railroad Club.

Robert S. Brown

Personal Mention

General

F. K. Mitchell, master mechanic of the New York Central System, at Indianapolis, Ind., has been appointed assistant superintendent of equipment.

T. C. Baldwin, master mechanic of the New York, Chicago & St. Louis at Conneaut, Ohio, has been appointed superintendent of motive power, with headquarters at Cleveland, Ohio.

H. L. Bonstein, chief draftsman in the office of the mechanical engineer of the Lehigh Valley, at Bethlehem, Pa., has been promoted to the position of mechanical engineer, with headquarters at Bethlehem, succeeding W. I. Cantley.

W. R. Sugg, superintendent of fuel conservation of the Missouri Pacific, has had his jurisdiction extended to cover the lubrication of locomotives.

F. K. Murphy, assistant superintendent of equipment of the New York Central System at Indianapolis, Ind., has been appointed superintendent of equipment, with the same headquarters, to succeed D. J. Mullen, retired.

D. J. Mullen, superintendent of equipment of the New York Central System at Indianapolis, Ind., has retired after 55 years' service with the company. Mr. Mullen was born on December 14, 1867, at Cincinnati, Ohio, and completed his education at Ohio Mechanical Institute. He entered railway service on November 17, 1882, as a machinist apprentice on the Cleveland, Cincinnati, Chicago & St. Louis (part of the New York Central System). Subsequently he was made a machinist and later served successively as gang foreman.

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enginehouse foreman at Cincinnati, and general foreman at Brightwood, Ind. In 1904 he was appointed master mechanic at Mt. Carmel, Ill., and in November, 1912, was transferred to Mattoon, Ill. Two years later Mr. Mullen was promoted to assistant superintendent of motive power, and in March, 1914, became superintendent motive power at Indianapolis. He had been superintendent of equipment since 1934.

Master Mechanics and Road Foremen

OSCAR G. PIERSON, who has been appointed master mechanic of the Oklahoma and Southern Kansas Division of the Atchison, Topeka & Santa Fe at Arkansas City, Kan., was born on June 1, 1889, at

O. G. Pierson

Topeka, Kan. He left school in June, 1906, and on April 30, 1907, entered the employ of the Santa Fe as a machinist apprentice at Topeka. He completed his apprenticeship on July 13, 1911, and worked as a machinist until April 1, 1912, when he became foreman of the air-brake room. He was transferred to Argentine, Kan., as a machinist gang foreman on September 2, 1914. On February 20, 1916, he became night enginehouse foreman at Arkansas City and on January 28, 1917, night enginehouse foreman at Argentine. Mr. Pierson resigned on March 17, 1918, to work in the navy yard at Washington, D. C. He returned to the Santa Fe on January 4, 1919, as a machinist at Argentine; on February 8, 1919, became machinist gang foreman; on June 19, 1919, air-brake foreman, and on March 3, 1920, enginehouse foreman. He became general foreman at Arkansas City on November 1, 1920, and district master mechanic on September 1, 1937.

J. J. MELLEN has been appointed master mechanic of the New York Central System with headquarters at Indianapolis, Ind., to succeed F. K. Mitchell.

W. R. WITHERSPOON, master mechanic of the Atlantic Coast Line at High Springs, Fla., has been appointed master mechanic, with headquarters at Florence, S. C., succeeding J. H. Painter, retired.

T. C. SHORTT, assistant to superintendent of motive power of the New York, Chicago & St. Louis, has been appointed master mechanic of the Nickel Plate district, succeeding T. C. Baldwin.

FRANK J. REGAN, road foreman of engines at Minneapolis, Minn., has been appointed master mechanic of the Yellowstone division of the Northern Pacific, with headquarters at Glendive, Mont., to succeed W. D. Gochenour.

A. T. MILLER, assistant to superintendent motive power and general storekeeper of the Atlanta & West Point, the Western Railway of Alabama, and the Georgia railroad, with headquarters at Atlanta, Ga., has been appointed master mechanic of these roads, with headquarters at Montgomery, Ala., and Augusta, Ga. On the latter road Mr. Miller succeeds O. H. Attridge, who has retired, and on the former roads he succeeds E. G. Gross, retired.

Car Department

A. J. KRUEGER has been appointed superintendent of the car department of the New York, Chicago & St. Louis, succeeding W. M. Wheatley, who has been assigned to other duties.

M. J. LACOURT, general car foreman of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis., is retiring at his own request after 40 years' service with the Milwaukee.

P. P. BARTHELEMY, whose appointment as master car builder of the Great Northern, at St. Paul, Minn., was reported in the January *Railway Mechanical Engineer*, has been in the service of the Great Northern for over 36 years. After attending the University of Minnesota, Mr. Barthelemy entered the service of the

P. P. Barthelemy

Great Northern as a mechanic in the shops at St. Cloud, Minn. He advanced successively through the positions of air brake foreman and assistant car foreman, later becoming car foreman at the Hillyard shops (Spokane, Wash.). From 1915 to 1917 he was engaged in car valuation work, then being appointed, successively, assistant general car foreman, general car foreman, assistant master car builder, and master car builder. Mr. Barthelemy is active in railway association work. He has served as president of the Northwest Car Men's Association, and is now director and a member of the Lubrication committee of the Car Department Officers' Association.

M. L. HYNES has been appointed general car department supervisor of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis., succeeding M. J. Lacourt.

E. F. PALMER, district car foreman of the Chicago, Milwaukee & St. Paul at Green Bay, Wis., has been appointed general car foreman with headquarters at Milwaukee, Wis., succeeding M. L. Hynes.

Shop and Enginehouse

L. M. CORNELL, enginehouse foreman of the Atlantic Coast Line at High Springs, Fla., has been appointed acting general foreman.

DONALD L. BRIGHTWELL, gang foreman of the Chesapeake & Ohio at Hinton, W. Va., has been promoted to the position of general foreman.

A. J. PICHETTO has been appointed general air-brake, steam-heat and lubrication engineer of the Illinois Central, with headquarters at Chicago, to succeed Emil Von Bergen.

WARREN D. GOCHENOUR, master mechanic of the Northern Pacific at Glendive, Mont., has been appointed shop superintendent at Livingston, Mont., to succeed Thomas Jackson, who has retired after 42 years with the Northern Pacific.

JOHN MATTISE, fuel supervisor of the Chicago & North Western, with headquarters at Chicago, has been appointed general air brake instructor with the same headquarters, to succeed William J. Devine, who has retired. Mr. Mattise has also been assigned to exercise general supervision over motive power lubrication.

FRANK T. MCCLURE, road foreman of engines on the Panhandle division of the Western lines of the Atchison, Topeka & Santa Fe, with headquarters at Wellington, Kan., has been promoted to supervisor of air brakes, with headquarters at Amarillo, Tex., succeeding F. C. Smith, who is retiring on pension after 32 years' service with the Santa Fe.

Obituary

A. G. SANDMAN, retired assistant to chief of motive power and equipment of the Baltimore & Ohio, died at his home in Baltimore, Md., on January 9. Before being pensioned on May 1, 1932, Mr. Sandman had been in active service of the Baltimore & Ohio for more than 52 years, during nearly all of which he was stationed at the Mount Clare shops in Baltimore. He was born October 19, 1862, in Germany, and was educated in the public schools of Baltimore county, Md., and Maryland Institute, Baltimore. Mr. Sandman entered the service of the Baltimore & Ohio as a machinist apprentice on October 7, 1879, becoming a machinist in 1883. Five years later he became a draftsman, being promoted to chief draftsman in 1901. For eight years, from July 16, 1918, to November 1, 1926, he was mechanical engineer. He was appointed assistant to chief of motive power and equipment on the latter date.